PROJECT MANUAL

Project #26064.00

WASTEWATER TREATMENT PLANT
EXPANSION AND RENOVATION
CONTRACT 3 – BIOSOLIDS SYSTEM ADDITION
BOWLING GREEN MUNICIPAL UTILITIES

July 12, 2010

STATE REVOLVING FUND NO. L34708

BGMU PROJECT NO. S07-653

GRESHAM, SMITH AND PARTNERS
ARCHITECTS / ENGINEERS
1400 Nashville City Center
511 Union Street, Suite 1400
Nashville, Tennessee 37219-1733
Telephone: 615.770.8100

Copyright 2010

TABLE OF CONTENTS

Division	Section Title	Pages
SERIES 00 – PROCUREMENT AND CONTRACTING REQUIREMENTS GROUP		
00 0107	Seals Pages	3
GENERAL REQUIREMENTS SUBGROUP		
DIVISION 01 – GENERAL REQUIREMENTS		
01 0000	General Requirements	4
01 1000	Summary	1
01 2219	Measurement and Payment	2
01 2600	Contract Modification Procedure	4
01 2900	Payment Procedures	3
01 3100	Project Management and Coordination	8
	Request for Information Form	1
01 3113.10	Mechanical and Electrical Coordination	4
01 3200	Construction Progress Documentation	9
01 3233	Photographic Documentation	2
01 3300	Submittal Procedures	7
01 4000	Quality Requirements	8
01 4200	References	6
01 4516	Uncovering and Correction of Work	1
01 5000	Temporary Facilities and Controls	7
01 5713	Temporary Erosion Prevention and Sediment Control	5
01 6000	Product Requirements	7
	Request for Substitution Form	2
01 6400	Owner Furnished Equipment	3
01 7300	Execution	7
01 7329	Cutting and Patching	4
01 7516	Start-Up Procedures	3
01 7700	Closeout Procedures	5
01 7823	Operation and Maintenance Data	8
	Maintenance Summary Form	1
01 7839	Project Record Documents	3
01 7900	Demonstration and Training	4
DIVISION 3 – CONCRETE		
03 1000	Concrete Joints and Joints Accessories	5
03 1100	Concrete Formwork	5
03 2000	Concrete Reinforcement	6
03 3000	Cast-in-Place Concrete	16
03 4100	Precast Structural Concrete	14
03 6000	Grout	8
DIVISION 4 – MASONRY		
04 2000	Unit Masonry	17

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

TABLE OF CONTENTS

Division	Section Title	Pages
DIVISION 5 – METALS		
05 5000	Metal Fabrications	5
05 5213	Tube Railings	8
DIVISION 7 – THERMAL AND MOISTURE PROTECTION		
07 1113	Bituminous Dampproofing	4
07 5423	Thermoplastic Polyolefin (TPO) Roofing	8
07 7100	Roof Specialties	8
07 9200	Joint Sealants	11
DIVISION 8 – OPENINGS		
08 1500	Fiberglass Reinforced (FRP) Doors and Frames	6
08 3323	Overhead Coiling Doors	8
08 4113	Aluminum Framed Entrances and Storefronts	8
08 7111	Door Hardware	18
08 8000	Glazing	10
08 9000	Louvers and Vents	6
DIVISION 9 – FINISHES		
09 5123	Acoustical Tile Ceilings	9
09 9653	Elastomeric Coatings	6
09 9911	Protective Coatings	18
	Coatings Coordination Supplement	4
FACILITY SERVICES SUBGROUP		
DIVISION 22 – PLUMBING		
22 0500	Common Work Results for Plumbing	12
22 0523	General-Duty Valves for Plumbing Piping	14
22 0529	Hangers and Supports for Plumbing Piping and Equipment	10
22 0548	Vibration and Seismic Controls for Plumbing Piping and Equipment	10
22 0553	Identification for Plumbing Piping and Equipment	5
22 0700	Plumbing Insulation	17
22 1116	Domestic Water Piping	22
22 1119	Domestic Water Piping Specialties	8
22 1316	Drainage and Vent Piping	9
22 1319	Drainage Piping Specialties	7
22 3300	Electric Domestic Water Heaters	6
22 4000	Plumbing Fixtures	11
DIVISION 23 – HEATING, VENTILATING AND AIR CONDITIONING (HVAC)		
23 0500	Common Work Results for HVAC	24
23 0529	Hangers and Supports for HVAC Piping and Equipment	12
23 0548	Vibration and Seismic Controls for HVAC Piping and Equipment	13
23 0553	Identification for HVAC Piping and Equipment	5
23 0593	Testing, Adjusting, and Balancing for HVAC	20

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

TABLE OF CONTENTS

Division	Section Title	Pages
DIVISION 23 – HEATING, VENTILATING AND AIR CONDITIONING (HVAC) (Continued)		
23 0700	HVAC Insulation	25
23 1123	Facility Natural-Gas Piping	20
23 2300	Refrigerant Piping	11
23 3113	Metal Ducts	12
23 3300	Air Duct Accessories	11
23 3423	HVAC Power Ventilators	6
23 3713	Diffusers, Registers, and Grilles	4
23 5100	Breechings, Chimneys, and Stacks	3
23 5533	Fuel-Fired Unit Heaters	4
23 8126	Split-System Air Conditioners	5
DIVISION 26 – ELECTRICAL		
26 0080	Electrical Testing	1
26 0500	Common Work Results for Electrical	4
26 0519	Low-Voltage Electrical Power Conductors and Cables	7
26 0526	Grounding and Bonding for Electrical Systems	6
26 0529	Hangers and Supports for Electrical Systems	6
26 0531	Cabinets and Enclosures	3
26 0533	Raceway and Boxes for Electrical Systems	2
26 0543	Underground Ducts and Raceways for Electrical Systems	11
26 0553	Identification for Electrical Systems	6
26 0573	Power Distribution Equipment Studies	5
26 2200	Low-Voltage Transformers	5
26 2413	Switchboards	9
26 2416	Panelboards	8
26 2726	Wiring Devices	7
26 2813	Fuses	3
26 2816	Enclosed Switches and Circuit Breakers	4
26 2915	Contactors	2
26 2923	Variable-Frequency Motor Controllers	10
26 4313	Transient-Voltage Suppression	4
26 5100	Building Lighting	7
26 5600	Site Lighting	8
DIVISION 28 – ELECTRONIC SAFETY AND SECURITY		
28 2300	Video Surveillance	13
SITE AND INFRASTRUCTURE SUBGROUP		
DIVISION 31 – EARTHWORK		
31 2300	Site Excavation, Backfilling, and Compaction	18
31 2500	Erosion and Sediment Control	8
31 6333	Drilled Micropiles	5
31 6813	Rock Foundation Anchors	6

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

TABLE OF CONTENTS

Division	Section Title	Pages
DIVISION 32 – EXTERIOR IMPROVEMENTS		
32 1216	Asphalt Paving	6
32 1313	Concrete Paving	12
32 9200	Lawns and Grasses	4
DIVISION 33 – UTILITIES		
33 1100	Water Distribution Piping	13
33 1219	Hydrants	4
33 3113	Sanitary Sewer (Gravity)	21
33 3913	Manholes	7
33 4000	Storm Drainage	9
33 5113	Gas Lines	9
PROCESS EQUIPMENT SUBGROUP		
DIVISION 40 – PROCESS INTEGRATION		
40 0523.33	Process Valves	17
40 2300	Process Piping	19
40 9000	Instrumentation and Control for Process Systems	14
40 9100	Instrumentation and Control Components	19
	Instrument Table and Mounting Instructions	3
40 9443	Programmable Logic Process Controllers	10
	Control Panel Schedule and Network Communications Cabinets	2
40 9500	Process Control Hardware	16
40 9600	Process Control Software	19
	Loop Descriptions	14
	PLC Input/Output List	9
40 9990	Package Control Systems	18
DIVISION 41 – MATERIAL PROCESSING AND HANDLING EQUIPMENT		
41 2213.13	Bridge Cranes	6
41 5616.10	Biosolids Storage System	16
DIVISION 43 – PROCESS GAS AND LIQUID HANDLING, PURIFICATION, AND STORAGE EQUIPMENT		
43 1400	Nitrogen Storage and Distribution System	6
DIVISION 44 – POLLUTION CONTROL EQUIPMENT		
44 4256.18	Progressive Cavity Pumps	13
44 4617	Wet Cake Hopper	12
44 4618	Indirect Dryer System	4
ATTACHMENTS		
Executed Therma-Flite Biosolids Dryer System IC-10000 BIO-SCRU Purchase Order Agreement		118

END OF TABLE OF CONTENTS

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

ARCHITECT

Division 04: All; Division 05: All; Division 07: All; Division 08: All; Division 09: Sections 09 5123 and 09 9653.

Gresham, Smith and Partners
511 Union Street, Suite 1400
Nashville, Tennessee 37219-1733

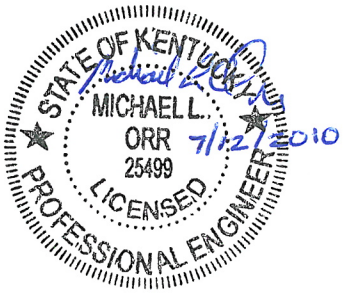


William L. Wood — Kentucky License No. 5092

CIVIL ENGINEER

Division 09: Section 09 9911; Division 31: All; Division 32: All; Division 33: All.

Gresham, Smith and Partners
511 Union Street, Suite 1400
Nashville, Tennessee 37219-1733

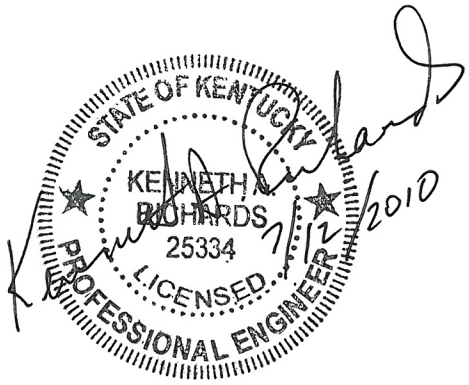


Michael L. Orr, P.E — Kentucky License No. 25499

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

Division 01: All; Division 40: All; Division 41: All; Division 43: All; Division 44: All.

Gresham, Smith and Partners
511 Union Street, Suite 1400
Nashville, Tennessee 37219-1733



Kenneth A. Richards, P.E.

Kentucky License No. 25334

STRUCTURAL ENGINEER

Division 03: All.

Teasley Services Group
4711 Trousdale Drive, Suite 215
Nashville, Tennessee 37220

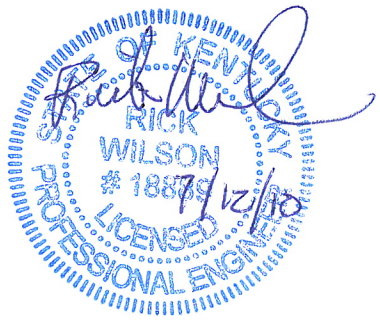
F. Lillard Teasley, P.E.

Kentucky License No. 20575

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

MECHANICAL ENGINEER
Division 22: All; Division 23: All.

Gresham, Smith and Partners
511 Union Street, Suite 1400
Nashville, Tennessee 37219-1733

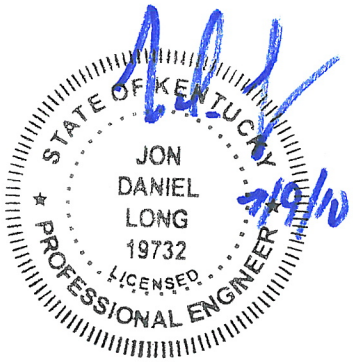


James R. Wilson, P.E

Kentucky License No. 18889

ELECTRICAL ENGINEER
Division 26: All.

Gresham, Smith and Partners
511 Union Street, Suite 1400
Nashville, Tennessee 37219-1733



Jon D. Long, P.E

Kentucky License No. 19732

END OF DOCUMENT

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This section includes general requirements of the Contract.

1.3 GENERAL REQUIREMENTS

A. General: The Contractor shall have full use of premises for construction operations, including use of project site during performance of the Work. The Contractor's use of premises is limited only by the Owner's right to perform work or to retain other contractors on portions of Project and conditions of any easement or right-or-way occupancy permits.

B. Prior to commencement of Work, the Contractor shall review the construction site with the Owner's representative to make permanent record of such existing damage as cracks, malfunctioning utility equipment and fixtures, or other similar damage. This record shall serve as a basis for determination of subsequent damage to the structures and adjacent areas due to the Contractor's operations. Any damage to these structures and adjacent areas not noted in original review record shall be reported immediately to the Owner. Permanent record shall include photographs and/or video graphic recording.

C. Smoking and Fire Precautions: No smoking, fire, or use of any fire- or explosion- producing tools or equipment will be permitted on the premises or at any locations where such may endanger said premises or the current operations thereon.

D. Manufacturers Qualifications: The manufacturers of all materials and equipment used must be approved by the Engineer and regularly engaged in the manufacture of the particular material or equipment for the use and service to which it will be subjected.

E. Compliance with state and local laws: Comply will all applicable requirements of state and local laws and ordinances to the extent that such requirements do not conflict with federal laws or regulations.

F. Protection of public and private property: The Contractor shall be responsible for preservation of and shall take special care in working areas to protect public and private property. The Contractor shall replace or repair at his own expense any damaged water pipes, power and communication lines, or other public utilities, roads, curbs, gutters, sidewalks, drain pipes, drainage ditches, all properties and fixtures (both permanent and temporary), and all plantings, including grass or sod on the site of the Work that are not to be demolished or disturbed.

G. Markers: Preserve all surveyed and privately owned markers and monuments; do not remove or disturb any such markers without prior approval from the Owner of the marker. Any removal and replacement of such markers shall be at the expense of the Contractor.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

H. Approved Chemicals: All chemicals used during project construction or furnished for project operation, whether herbicide, pesticide, disinfectant, polymer, reactant, or of other classification, must show approval of either EPA or USDA. The use of all such chemicals and the disposal of residues shall be in strict conformance with manufacturer's instructions.

I. Catalog Data for Owners: Provide duplicate complete, bound sets of a compilation of catalog data of each manufactured item of mechanical and electrical equipment used in the Work, for transmittal to the Owner before payment of more than ninety percent (90%) is made. Include descriptive data and printed installation, operating, and maintenance instructions (including a parts list for each item of equipment). Provide a complete double index as follows:
   1. List the products alphabetically by name.
   2. List alphabetically the names of manufacturers whose products have been incorporated in the work, together with their addresses and the names and addresses of the local sales representative.

J. Installation, Testing and Guarantee: Install all materials and equipment exactly in accordance with the manufacturer's recommendations. The completely installed system shall be guaranteed against any and all defects of manufacture, materials, workmanship, or installation for a period of one year from the date of Substantial Completion.

K. Operation and Maintenance of the Systems and Instruction to Owner: Where the specifications for equipment require that a factory service representative provide operation and maintenance instruction to the Owner for that equipment, this service shall be performed by prior arrangement with the Owner after and in addition to the manufacturer's instructions to the Contractor for installation and start-up. The individual performing the instructions to the Owner is to be trained and/or certified by the manufacturer as its authorized operation, maintenance, and service specialist. If the said specialist is not a regular, full-time employee of the manufacturer, the specialist's qualifications shall be submitted to the Owner for review and approval prior to scheduling the site visit for instructions to the Owner.

L. Drawings of Record: Provide and keep up-to-date a complete record set of drawings, which shall be corrected daily to show every change. Keep this set of prints at the job site, and use only as a record set. This shall not be construed as authorization for the Contractor to make changes in the approved layout without definite instructions in each case. The record set shall be provided to the Owner upon completion of the project.

M. Preservation of Existing Vegetation: Take reasonable care during construction to avoid damage to vegetation located outside construction limits. Where the area to be excavated is occupied by trees, brush, or other uncultivated vegetable growth, clear such growth from the area, and dispose of it in a manner satisfactory to the Owner. Leave undisturbed any trees, cultivated shrubs, flowers, etc., situated within public rights-of-way and/or easements through private property but not located directly within construction limits. Transplant small ornamental trees, cultivated shrubs, flowers, etc., located directly within construction limits so they may be replaced during property restoration operations. Do not remove or disturb any tree larger than six inches (6") in diameter without the permission of the Owner. Take special precautions (including provision of barricades and temporary tying back of shrubbery and tree branches) for the protection and preservation of such objects throughout all stages of construction; the Contractor will be held liable for any damage that may result to said objects

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

from excavation or construction operations. Trim any limbs or branches of trees broken during construction operations with a clean cut, and paint with an approved tree pruning compound. Tree trunks receiving damage from equipment shall be treated with an approved tree dressing.

N. Existing Utilities: The Work shall be performed so as to cause minimum interference or interruption with the normal operation of the existing utilities. The Contractor shall plan and conduct construction sequencing operations to avoid disturbing existing utilities and equipment, except as may be provided or approved by the Engineer. The Contractor is responsible for locating all existing utilities prior to construction and shall carefully protect from damage all utilities in the vicinity of the work that are to remain. The Contractor shall be responsible for repairing any utilities not to be demolished that are damaged by his activities. If it is necessary to repair, remove, and/or replace any such utility in order to complete the Work properly, do so in compliance with the rules, regulations, and approval of the particular utility involved. Any such work shall be considered incidental to the performance of the Work, and no additional payment will be allowed therefor. Existing utilities that are not to be demolished shall remain in service at all times during construction.

O. Contractor shall comply with the requirements of the Manual on Uniform Traffic Control Devices published by the U.S. Department of Transportation Federal Highway Administration in supplying adequate signage, flagging, personnel, etc. for the entire project. The Contractor shall be responsible for the placement and removal of all signage.

P. The Contractor shall maintain an acceptable flow of traffic through construction areas. If a roadway must be closed in order to construct the Work, the Contractor shall notify local law enforcement, 911 call center, local school superintendent, and U.S. Postal Service, at a minimum, at least two days prior to roadway closure.

Q. Work in Rights-of-Way:
1. The Contractor shall notify the authorities having jurisdiction prior to entering and working in rights-of-way and shall be responsible for all damages resulting from said Work and for satisfying the requirements of said authorities.
2. The Contractor shall maintain a suitable and safe condition throughout the right-of-way affected by the Work and provide detours as necessary for public and private traffic.
3. Materials excavated in rights-of-way shall be hauled to a disposal site immediately and shall not be stockpiled in right-of-way.

R. Observation of Work: The Contractor shall provide full access to the project site at all times for observation of Work by the Owner, Engineer, and agents of any local, state, or federal agency having jurisdiction.

S. Flood Insurance: The Contractor is required to carry flood insurance for Work which is located in designated flood hazard areas unless insurance is not available.

T. Safety: Any construction personnel on plant property shall attend a safety orientation provided by the Owner. Each construction personnel will be issued a badge after completion of the safety orientation that will be returned at the end of the job. Replacement cost for each lost badge will $20.00. Each construction personnel must have their issued badge with them at all times while on site. Background checks are subject to the Owner's discretion.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Project Description: The work is generally described as follows:
   1. Construction and installation of a Biosolids Dryer Building, which includes the following equipment:
      a. Wet cake hoppers with live bottoms;
      b. Progressive cavity pumps;
      c. Indirect dryer pre-purchased by the Owner including cooling screw, condenser scrubber, thermal fluid heater, expansion tank, de-aerator tank, buffer tank, and biological odor control system;
      d. Catchment tank;
      e. Pneumatic conveyance system, including surge bin, rotary positive displacement pressure blower, and conveying pipeline;
      f. Storage silos;
      g. Nitrogen system for fire suppression;
      h. Mineral oil system for dust suppression;
      i. Instrumentation and controls; and
      j. All appurtenances required for complete and operable systems.
   2. Construction of a Sales Office for the dried product adjacent to the Dryer Building. Common wall construction should be utilized.
   3. All relevant site utilities including, but not limited to, stormwater, wastewater, potable water, plant water, gas, electric, and telephone.
   4. Temporary erosion prevention and sediment control measures.
   5. Finish grading, pavement, and fencing.

B. The Owner has pre-purchased the indirect dryer system to be delivered to the Project site April 2011. If Contractor needs equipment on site before this date, coordination between equipment supplier and Contractor shall take place. In the event the Project is delayed for any reason and the equipment cannot be delivered to the Project site, the equipment supplier will store equipment until delivery arrangements can be made.

C. Project Location: Bowling Green Municipal Utilities Wastewater Treatment Plant site located at 1189 Preston Avenue, Bowling Green, Kentucky 42101.

D. Owner: Bowling Green Municipal Utilities.
   1. Owner's Representative: Mr. Keith Williams, Purchasing Agent.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

B. Related Sections include the following:
   1. Division 01 Section "Contract Modification Procedures" for procedures for submitting and handling Contract Modifications.
   2. Division 01 Section "Quality Requirements" for administrative and procedural requirements for quality assurance and quality control.
   3. Division 01 Section "Payment Procedures" for administrative and procedural requirements necessary to prepare and process Applications for Payment.

1.2 SUMMARY

A. This Section includes administrative and procedural requirements for measurement and payment.

B. The Contractor shall furnish all necessary labor, materials, machinery, equipment, tools, apparatus, service, and other necessary supplies required. Contractor shall perform any associated quality control, environmental protection, safety requirements, tests, and reports, as shown on the Drawings and/or described in the Specifications at the negotiated proposal price. The Work shall be complete-in-place and ready for operation.

C. All costs for items of work, which are not specifically mentioned to be included in the negotiated proposal price payment item, shall be considered incidental to the Work and the cost of such shall be included in the negotiated proposal price.

D. The Contractor has become thoroughly familiar with the terms and conditions of the Contract Documents including all local conditions affecting the performance and costs of the Work at the place where the Work is to be completed, and has fully inspected the site in all particulars informing himself fully regarding all conditions pertaining to the Work site.

E. When actual field conditions differ from assumed design conditions and result in a reduction in materials, equipment, and appurtenances to be installed, a negative adjustment will be made to the Contract. Items provided on the Contract 2 bid form will be used for adjustment, otherwise, the Contractor shall provide costs for a Change Order.

F. The unit prices in Contract 2 for Items to Cover Authorized Changes will only be used for changes authorized by the Engineer. Adjustments to the negotiated proposal price will be made in the Final Balancing Change Order to reflect actual quantities used due to changes authorized by the Engineer.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

MEASUREMENT AND PAYMENT

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section specifies administrative and procedural requirements for handling and processing Contract modifications.

B. Related Sections include the following:
   1. Division 01 Section "Measurement and Payment" for administrative requirements for unit pricing.
   2. Division 01 Section "Payment Procedures" for administrative requirements for preparation and processing payments for changes in the work.
   3. Division 01 Section "Product Requirements" for selection of products for changes in the work.
   4. Division 01 Section "Construction Progress Documentation" for developing a schedule for additional work.

1.3 MINOR CHANGES IN THE WORK

A. Engineer will issue a field order authorizing Minor Changes in the Work, not involving adjustment to the Contract Sum or the Contract Time.

1.4 PROPOSAL REQUESTS

A. Owner-Initiated Proposal Requests: Engineer will issue a detailed description of proposed changes in the Work that may require adjustment to the Contract Sum or the Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications.
   1. Proposal Requests issued by Engineer are for information only. Do not consider them instructions either to stop work in progress or to execute the proposed change.
   2. Within 10 days after receipt of Proposal Request, submit a quotation estimating cost adjustments to the Contract Sum and the Contract Time necessary to execute the change.
      a. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
      b. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
      c. Include costs of labor and supervision directly attributed to the charges.
      d. Include an updated Contractor's Construction Schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Contractor-Initiated Proposals: If latent or unforeseen conditions require modifications to the Contract, Contractor may propose changes by submitting a request for a change to the Engineer.
   1. Include a statement outlining reasons for the change and the effect of the change on the Work. Provide a complete description of the proposed change. Indicate the effect of the proposed change on the Contract Sum and the Contract Time.
   2. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
   3. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
   4. Include costs of labor and supervision directly attributed to the charges.
   5. Include an updated Contractor's Construction Schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship.
   6. Comply with requirements in Division 01 Section "Product Requirements" if the proposed change requires substitution of one product or system for product or system specified.

1.5 CONSTRUCTION CHANGE DIRECTIVES

A. In absence of total agreement on the terms of a Change Order, the Engineer may prepare and issue a Construction Change Directive directing a change in the Work, for subsequent inclusion in a Change Order.
   1. Construction Change Directive will describe changes in the Work, and describe the method of determining any change in the Contract Sum or Contract Time, or both.
   2. Construction Change Directive will be signed by Owner and Engineer.

B. Upon receipt of a Construction Change Directive, Contractor shall do the following:
   1. Promptly proceed with the change in the Work involved.
   2. Promptly advise the Engineer of the Contractor's agreement or disagreement with the method, if any, provided in the Construction Change Directive for determining the proposed adjustment in the Contract Sum or Contract Time.

C. A Construction Change Directive signed by the Contractor indicates the agreement of the Contractor therewith, including adjustment in Contract Sum and Contract Time or the method for determining them.
   1. Such agreement shall be effective immediately and shall be recorded as a Change Order.
   2. If Contractor does not respond promptly or disagrees with the Construction Change Directive, he shall comply with General Conditions.

D. A Construction Change Directive shall be processed in compliance with requirements of the General Conditions.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1.6 DOCUMENTATION OF PROPOSALS AND CLAIMS

A. Support each quotation for a lump-sum proposal, and for each unit price which has not previously been established, with sufficient substantiating data to allow the Engineer to evaluate the quotation.

B. On request provide additional data to support time and cost computations:
   1. Labor required.
   2. Equipment required.
   3. Products required:
      a. Recommended source of purchase and unit cost.
      b. Quantities required.
   4. Taxes, insurance and bonds.
   5. Credit for work deleted from Contract, similarly documented.
   6. Overhead and profit, for subcontractor and General Contractor separately.
   7. Justification for any change in Contract Time.

C. Support each claim for additional costs, and for work done on a time-and-material/force account basis, with documentation as required for a lump-sum proposal, plus the following additional information:
   1. Name of the Owner's authorized agent who ordered the Work, and date of the order.
   2. Dates and hours work was performed, and by whom.
   3. Time record, summary of hours worked, and hourly rates paid.
   4. Receipts and invoices for:
      a. Equipment used, listing dates and times of use.
      b. Products used, listing of quantities.
      c. Subcontracts.
      d. Overhead and Profit, Taxes, Insurance.

D. Document requests for substitutions for Products as specified in Division 01 Section "Product Requirements".

E. Support each claim for additional Contract time with a detailed time impact analysis using the Network Analysis Procedure Outline in Division 01 Section "Construction Progress Documentation".

F. All weather related Change Order Requests must be substantiated by NOAA data.

1.7 PREPARATION OF CHANGE ORDERS

A. Engineer will prepare each Change Order to address specific issues unless mutually agreed to do otherwise by all parties.

B. Change Order will describe changes in the Work, both additions and deletions, with attachments of revised Contract Documents to define details of the change.

C. Change Order will provide an accounting of the adjustment in the Contract Sum and in the Contract Time.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1.8 LUMP-SUM/FIXED PRICE CHANGE ORDER

A. Content of Change Orders will be based on, either:
   1. Engineer's Proposal Request and Contractor's responsive Proposal as mutually agreed between Owner and Contractor.
   2. Contractor's Proposal for a change, signed by the Contractor, as recommended by Engineer.

B. Owner and Engineer will sign and date the Change Order as authorization for Contractor to proceed with changes, after Contractor has signed the Change Order.

1.9 TIME AND MATERIAL/FORCE ACCOUNT CHANGE ORDER/CONSTRUCTION CHANGE AUTHORIZATION

A. Engineer or Owner will issue a Construction Change Directive directing Contractor to proceed with the changes.

B. Contractor shall submit daily itemized accounting and supporting data as provided in the Article "Documentation of Proposals and Claims" of this Section. At completion of the change, Contractor shall submit a complete itemized accounting of the change along with all supporting data.

C. Engineer will determine the allowable cost of such work, as provided in General Conditions and Supplementary Conditions, and based on Contractor's submitted data.

D. Engineer will sign and date the Change Order to establish the change in Contract Sum and in Contract Time.

E. Owner and Contractor will sign and date the Change Order to indicate their agreement therewith.

1.10 CORRELATION WITH CONTRACTOR'S SUBMITTALS

A. Periodically revise Schedule of Values and Request for Payment forms to record each change as a separate item of Work, and to record the adjusted Contract Sum.

B. Periodically revise the Construction Schedule to reflect each change in Contract Time.
   1. Revise sub-schedules to show changes for other items of Work affected by the changes.

C. Upon completion of Work under a Change Order, enter pertinent changes in Record Documents.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section specifies administrative and procedural requirements necessary to prepare and process Applications for Payment.

B. Related Sections include the following:
   1. Division 01 Section "Measurement and Payment" for administrative requirements governing the use of unit prices.
   2. Division 01 Section "Contract Modification Procedures" for administrative procedures for handling changes to the Contract.
   3. Division 01 Section "Project Management and Coordination" for additional requirements for applications for payments.
   4. Division 01 Section "Construction Progress Documentation" for administrative requirements governing preparation and submittal of Contractor's Construction Schedule and Submittals Schedule.

1.3 DEFINITIONS

A. Schedule of Values: A statement furnished by Contractor allocating portions of the Contract Sum to various portions of the Work and used as the basis for reviewing Contractor's Applications for Payment.

B. Stored Materials: Product values that may be claimed on an Application for Payment. Product invoices must be provided with Application for Payment to substantiate the value of the Stored Materials claim. Stored Materials are associated with portions of the work that are represented by Bid Form or Schedule of Values line items and will be limited on the Application for Payment to a maximum of 30 percent of the total amount bid. Deviations to this standard shall be as approved by the Owner and Engineer. The Stored Materials value will be reduced on each Application for Payment based on the total contract value complete to date of said Application for Payment. The Stored Materials value will be reduced to zero upon original Substantial Completion date.

1.4 SCHEDULE OF VALUES

A. Coordination: Coordinate preparation of the Schedule of Values with preparation of Contractor's Construction Schedule.
   1. Correlate line items in the Schedule of Values with other required administrative forms and schedules, including the following:
      a. Application for Payment forms with Continuation Sheets.
      b. Submittals Schedule.
   2. Submit the Schedule of Values to Engineer at earliest possible date but no later than 14 days before the date scheduled for submittal of initial Applications for Payment.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Format and Content: Use the Project Manual table of contents as a guide to establish line items for the Schedule of Values. When deemed necessary, the Engineer will provide the Contractor with a Schedule of Values list. Provide at least one line item for each Specification Section.
   1. Arrange the Schedule of Values in tabular form with separate columns to indicate the following for each item listed:
      a. Description of the Work.
      b. Change Orders (numbers) that affect value.
      c. Dollar value.
         1) Percentage of the Contract Sum to nearest one-hundredth percent, adjusted to total 100 percent.
   2. Provide a breakdown of the Contract Sum in enough detail to facilitate continued evaluation of Applications for Payment and progress reports. Coordinate with the Project Manual table of contents. Provide several line items for principal subcontract amounts, where appropriate.
   3. Round amounts to nearest whole dollar; total shall equal the Contract Sum.
   4. Provide a separate line item in the Schedule of Values for each part of the Work where Applications for Payment may include materials or equipment purchased or fabricated and stored, but not yet installed.
      a. Differentiate between items stored on-site and items stored off-site. Include evidence of insurance or bonded warehousing if required.
   5. Each item in the Schedule of Values and Applications for Payment shall be complete. Include total cost and proportionate share of general overhead and profit for each item.
      a. Temporary facilities and other major cost items that are not direct cost of actual work-in-place may be shown either as separate line items in the Schedule of Values or distributed as general overhead expense, at Contractor's option.

C. Schedule Updating: Update and resubmit the Schedule of Values before the next Application for Payment when Change Orders or Construction Change Directives result in a change in the Contract Amount.

1.5 APPLICATIONS FOR PAYMENT

A. Each Application for Payment shall be consistent with previous applications and payments as certified by Engineer and paid for by Owner.
   1. Initial Application for Payment, Application for Payment at time of Substantial Completion, and final Application for Payment have individual requirements.

B. Payment Application Times: The closing date for each progress payment shall be established at the pre-construction conference. The period covered by each Application for Payment starts on the day following the end of the preceding application period.

C. Payment Application Forms: Use EJCDC No. C-620 (2007 Edition), Contractor’s Application for Payment form.

D. Application Preparation: Complete every entry on form. Execute by a person authorized to sign legal documents on behalf of Contractor. Engineer will return incomplete applications without action.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1. Entries shall match data on the Schedule of Values and Contractor's Construction Schedule. Use updated schedules if revisions were made.
2. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.
3. Include Stored Materials values, as applicable.

E. Transmittal: Submit five executed original copies of each Application for Payment to Engineer by a method ensuring receipt.

F. Initial Application for Payment: Administrative actions and submittals that must precede or coincide with submittal of first Application for Payment include the following:
1. List of subcontractors.
2. Schedule of Values.
3. Contractor's Construction Schedule (preliminary if not final).
4. Products list.
5. Schedule of unit prices.
6. Submittals Schedule (preliminary if not final).
7. List of Contractor's staff assignments.

G. Application for Payment at Substantial Completion: After issuing the Certificate of Substantial Completion, submit an Application for Payment showing 100 percent completion for portion of the Work claimed as substantially complete.
1. Include documentation supporting claim that the Work is substantially complete and a statement showing an accounting of changes to the Contract Sum.
2. This application shall reflect Certificates of Partial Substantial Completion issued previously for Owner occupancy of designated portions of the Work.

H. Final Payment Application: Submit final Application for Payment with releases and supporting documentation not previously submitted and accepted, including, but not limited, to the following:
1. Evidence of completion of Project closeout requirements.
2. Insurance certificates for products and completed operations where required and proof that taxes, fees, and similar obligations were paid.
3. Updated final statement, accounting for final changes to the Contract Sum.
4. AIA Document G706, "Contractor's Affidavit of Payment of Debts and Claims."
5. AIA Document G706A, "Contractor's Affidavit of Release of Liens."
6. AIA Document G707, "Consent of Surety to Final Payment."
7. Evidence that claims have been settled.
8. Final, liquidated damages settlement statement.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:
   1. Project meetings.
   2. Requests for Information (RFIs).

B. Related Sections include the following:
   1. Division 01 Section "Construction Progress Documentation" for preparing and submitting Contractor's Construction Schedule.
   2. Division 01 Section "Execution" for procedures for coordinating general installation and field-engineering services, including establishment of benchmarks and control points.
   3. Division 01 Section "Closeout Procedures" for coordinating closeout of the Contract.

1.3 DEFINITIONS

A. RFI: Request from Contractor seeking interpretation or clarification of the Contract Documents.

1.4 COORDINATION

A. Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations, included in different Sections, which depend on each other for proper installation, connection, and operation.
   1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
   2. Make adequate provisions to accommodate items scheduled for later installation.
   3. Where availability of space is limited, coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair of all components, including mechanical and electrical.

B. Prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.
   1. Prepare similar memoranda for Owner and separate contractors if coordination of their Work is required.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

C. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities and activities of other contractors to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:
   1. Preparation of Contractor's Construction Schedule.
   2. Preparation of the Schedule of Values.
   3. Installation and removal of temporary facilities and controls.
   4. Delivery and processing of submittals.
   5. Progress meetings.
   6. Preinstallation conferences.
   7. Project closeout activities.
   8. Startup and adjustment of systems.
   9. Project closeout activities.

D. Communication Procedures: The Owner and Contractor shall communicate with each other through the Engineer about matters related to the Contract, unless otherwise provided in the Contract Documents or when direct communications have been specially authorized. Communications by and with the Engineer's consultants shall be through the Engineer. Communications by and with subcontractors and material suppliers shall be through the Contractor.

E. Conservation: Coordinate construction activities to ensure that operations are carried out with consideration given to conservation of energy, water, and materials. Salvage materials and equipment involved in performance of, but not actually incorporated into, the Work.

1.5 SUBMITTALS

A. Coordination Drawings: Prepare Coordination Drawings where limited space availability necessitates maximum utilization of space for efficient installation of different components or if coordination is required for installation of products and materials fabricated by separate entities.
   1. Content: Project-specific information, drawn accurately to scale. Do not base Coordination Drawings on reproductions of the Contract Documents or standard printed data. Include the following information, as applicable:
      a. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems. Including the following:
         1) Beams with sizes shown
         2) All sheet metal work
         3) Mechanical piping, sized 3 inches and above
         4) Plumbing piping, sized 1-1/2 inch and above
         5) Fire protection piping
         6) Electrical conduit
         7) Lights
         8) Dampers including maintenance access
         9) Shaft pulls
         10) Coil pulls
         11) Mechanical, plumbing, and electrical access areas
         12) Access panel locations and sizes

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

13) Maintenance clearances
14) HVAC equipment
15) Pneumatic tube system piping
16) Security systems
17) Ceiling heights
18) All existing structure, HVAC ductwork, HVAC piping, plumbing, electrical conduits and other items that are existing and will remain.
19) Indicate required installation sequences.

b. Indicate required installation sequences.

c. Indicate dimensions shown on the Contract Drawings and make specific note of dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Engineer for resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.

2. Drawing Scale: Drawings shall be 1/4 inch = 1'-0" scale for overall floor plans and 1/2 inch = 1'-0" for equipment and mechanical room floor plans.
3. Sheet Size: At least 18 by 24 inches but no larger than 34 by 44 inches.
4. Number of Copies: Submit two opaque copies of each submittal. Engineer will return one copy.
   a. Submit five copies where Coordination Drawings are required for operation and maintenance manuals. Engineer will retain two copies; remainder will be returned. Mark up and retain one returned copy as a Project Record Drawing.
5. Refer to Division 01 Section "Submittal Procedures" for Coordination Drawing requirements.

B. Key Personnel Names: Within 15 days of starting construction operations, submit a list of key personnel assignments, including superintendent and other personnel in attendance at Project site. Identify individuals and their duties and responsibilities; list addresses and telephone numbers, including home and office telephone numbers. Provide names, addresses, and telephone numbers of individuals assigned as standbys in the absence of individuals assigned to Project.
   1. Post copies of list in Project meeting room, in temporary field office, and by each temporary telephone. Keep list current at all times.

1.6 ADMINISTRATIVE AND SUPERVISORY PERSONNEL

A. General: In addition to Project superintendent, provide other administrative and supervisory personnel as required for proper performance of the Work.

1.7 PROJECT MEETINGS

A. General: Schedule and conduct meetings and conferences at Project site, unless otherwise indicated.
   1. Attendees: Inform participants and others involved, and individuals whose presence is required, in writing seven working days prior to each meeting, of date and time of meeting. Notify Owner and Engineer of scheduled meeting dates and times.
   2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3. Minutes: Record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner and Engineer, within three days of the meeting.

B. Preconstruction Conference: Schedule a preconstruction conference before starting construction, at a time convenient to Owner and Engineer, but no later than 15 days after execution of the Agreement. Hold the conference at Project site or another convenient location. Conduct the meeting to review responsibilities and personnel assignments.
   1. Attendees: Authorized representatives of Owner, Engineer, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. All participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
   2. Agenda: Discuss items of significance that could affect progress, including the following:
      a. Tentative construction schedule.
      b. Phasing.
      c. Critical work sequencing and long-lead items.
      d. Designation of key personnel and their duties.
      e. Procedures for processing field decisions, Proposal Requests and Change Orders.
      f. Procedures for RFIs.
      g. Procedures for testing and inspecting.
      h. Procedures for processing Applications for Payment.
      i. Distribution of the Contract Documents.
      j. Submittal procedures.
      k. LEED requirements.
      l. Procedures for Maintaining and Preparation of Record Documents.
      m. Use of the premises.
      n. Work restrictions.
      o. Owner's occupancy requirements.
      p. Responsibility for temporary facilities, utilities and controls.
      q. Construction waste management and recycling.
      r. Parking availability.
      s. Office, work, and storage areas.
      t. Equipment deliveries and priorities.
      u. First aid.
      v. Security.
      w. Working hours.
   3. Minutes: Record and distribute meeting minutes.

C. Preinstallation Conferences: Conduct a preinstallation conference at Project site before each construction activity that requires coordination with other construction.
   1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Engineer of scheduled meeting dates.
   2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:
      a. The Contract Documents.
      b. Options.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

c. Related RFIs.
d. Related Change Orders.
e. Purchases.
f. Deliveries.
g. Submittals.
h. Possible conflicts.
i. Compatibility problems.
j. Time schedules.
k. Weather limitations.
l. Manufacturer's written recommendations.
m. Warranty requirements.
n. Compatibility of materials.
o. Acceptability of substrates.
p. Temporary facilities and controls.
q. Space and access limitations.
r. Regulations of authorities having jurisdiction.
s. Testing and inspecting requirements.
t. Installation procedures.
u. Coordination with other work.
v. Required performance results.
w. Protection of adjacent work.
x. Protection of construction and personnel.

3. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.
4. Reporting: Distribute minutes of the meeting to each party present and to parties who should have been present.
5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.

D. Progress Meetings: Conduct progress meetings at weekly intervals. Coordinate dates of meetings with preparation of payment requests.
1. Attendees: In addition to representatives of Owner and Engineer, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
2. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's Construction Schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
1) Review schedule for next period.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

b. Review present and future needs of each entity present, including the following:
   1) Interface requirements.
   2) Sequence of operations.
   3) Status of submittals.
   4) Deliveries.
   5) Off-site fabrication.
   6) Access.
   7) Site utilization.
   8) Temporary facilities and controls.
   9) Work hours.
   10) Hazards and risks.
   11) Progress cleaning.
   12) Quality and work standards.
   13) Status of correction of deficient items.
   14) Field observations.
   15) RFIs.
   16) Status of proposal requests.
   17) Pending changes.
   18) Status of Change Orders.
   19) Pending claims and disputes.
   20) Documentation of information for payment requests.

3. Minutes: Contractor will record and distribute to Owner and Engineer the meeting minutes.
4. Reporting: Distribute minutes of the meeting to each party present and to parties who should have been present.
   a. Schedule Updating: Revise Contractor's Construction Schedule after each progress meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.

1.8 REQUESTS FOR INFORMATION (RFIs)

A. Procedure: Immediately on discovery of the need for information of the Contract Documents, and if not possible to request information at Project meeting, prepare and submit an RFI in the form specified.
   1. RFIs shall originate with Contractor. RFIs submitted by entities other than Contractor will be returned with no response.
   2. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.

B. Submittal of an RFI constitutes representation that the Contractor requires additional information about the Contract Documents AFTER he has made careful study and comparison of the Contract Documents, field conditions, other Owner-provided information, Contractor-prepared coordination drawings, and prior project correspondence or documentation.

C. If upon evaluation of the RFI the Engineer finds that the requested information is contained in the Contract Documents or by other documents and/or methods as outlined in paragraph above, the Owner has the option to obtain reimbursement from the Contractor for costs incurred by the Owner for the Engineer's services and expenses made necessary in answering such requests.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

D. Content of the RFI: Include a detailed, legible description of item needing information and the following:
   1. Project name.
   2. Date submitted to the Engineer.
   3. Name of Contractor.
   4. Name of Engineer.
   5. RFI number, numbered sequentially by the Contractor as they are submitted to the Engineer.
   6. Specification Section number and title and related paragraphs, as appropriate.
   7. Drawing number and detail references, as appropriate.
   8. Discipline (Architecture, Structural, Mechanical, Electrical, etc.).
   9. Field dimensions and conditions, as appropriate.
   10. Contractor's suggested solution(s). If Contractor's solution(s) impact the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
   11. Contractor's signature.
   12. Attachments: Include drawings, descriptions, measurements, photos, Product Data, Shop Drawings, and other information necessary to fully describe items needing interpretation.
      a. Supplementary drawings prepared by Contractor shall include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments.
   13. Date information required (See paragraph 1.8F).

E. Hard-Copy RFIs: Form at end of this Section.
   1. Identify each page of attachments with RFI number and sequential page number.

F. Engineer's Action: Engineer will review each RFI, determine action required, and return it. Allow five working days for Engineer's response for each RFI. RFIs received after 2:00 p.m. local time will be considered as received the following working day.
   1. If the date of response requested is less than five working days, the Engineer will endeavor to respond when requested, however a failure to respond prior to the requested date shall not be the sole basis for any delay claims of time or money.
   2. The following RFIs will be returned without action:
      a. Requests for approval of submittals.
      b. Requests for approval of substitutions.
      c. Requests for coordination information already indicated in the Contract Documents.
      d. Requests for adjustments in the Contract Time or the Contract Sum.
      e. Requests for interpretation of Engineer's actions on submittals.
      f. Incomplete RFIs or RFIs with numerous errors.
   3. Engineer's action may include a request for additional information, in which case Engineer's time for response will start again.
   4. Engineer's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal according to Division 01 Section "Contract Modification Procedures."
      a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Engineer in writing within five working days of receipt of the RFI response.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

Gresham, Smith and Partners

Request For Information (RFI)

Requested Reply Date:

Project Name: Wastewater Treatment Plant Expansion & Renovation – Contract 3

Project Number: 26064.00

RFI Number	Submitted To:	Submitted By:	Copies To:
Date			

Subject	Discipline	Co-Author

REFERENCE ATTACHMENTS: *(List specific documents researched when seeking the information requested.)*

Specification Section	Drawing Reference	Other

RFI DESCRIPTION: *(Fully describe the question or type of information requested.)*

SENDER'S RECOMMENDATION: *(if RFI concerns a site or construction condition, the sender may provide a recommendation, including cost and/or schedule considerations.)*

RESPONSE:

Note: By responding to the RFI, we do not agree to any additional costs and/or time. Any additional costs and/or time shall be submitted in accordance with the requirements of the Contract Documents.

Date Answered: Answered By:

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Mechanical and Electrical Coordination.

B. Submittals.

C. Coordination required.

D. Coordination documents.

E. Coordination of submittals.

F. Coordination of substitutions and modifications.

G. Observation of Work.

H. Documentation.

I. Equipment start-up.

J. Inspection and acceptance of equipment.

1.3 MECHANICAL AND ELECTRICAL WORK COORDINATOR

A. Employ and pay for services of a person technically qualified and experienced in field coordination for the type of process, and mechanical, instrumentation, and electrical work required for this Project for the duration of the Work.

1.4 SUBMITTAL PROCEDURES

A. Submit name, address, and résumé of Coordinator to Engineer for review.

B. Submit coordination drawings with shop drawings. Submit schedules prior to submitting shop drawings, product data, and samples.

1.5 COORDINATION REQUIRED

A. Coordinate all mechanical and electrical work.

B. Coordinate progress schedules, including dates for submittals and for delivery of products.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

C. Conduct conferences among related subcontractors, vendors and others concerned with the Work, to establish and maintain coordination and schedules, and to resolve coordination matters in dispute. Maintain notes of all Coordination Meetings and provide notes upon request.

D. Participate in progress meetings and pre-installation conferences. Report on progress of Work to be adjusted under coordination requirements, and any required changes in schedules.

1.6 COORDINATION DOCUMENTS

A. Prepare coordination drawings to show interconnecting wiring, size and number of wiring, interlocks, equipment connections, termination points, starter sizes, breaker size, motor size, alarms, and other devices required for operation in schematic form. Organize installation of products for efficient use of available space, proper sequence of installation, and to identify potential conflicts.

B. Prepare a master schedule to identify responsibilities under each section of Divisions 1 through 44 of the Specifications for activities which directly relate to this Work, including submittals and temporary utilities. Identify electrical power characteristics and control wiring required for each item of equipment.

C. Maintain documents and redline record drawings for the duration of the Work, recording changes due to site instructions, modifications, or adjustments.

D. After Engineer review of original and revised documents, reproduce and distribute to concerned parties.

1.7 COORDINATION OF SUBMITTALS

A. Review shop drawings, product data, and samples for compliance with Contract Documents and for coordination among work of all sections of the Project Manual. Transmit to Contractor for review and approval, prior to submission to Engineer.

B. Check field dimensions and clearances and relationship to available space and anchors.

C. Check compatibility with equipment and Work of other sections, electrical characteristics, and operational control requirements.

D. Check motor voltages and control characteristics.

E. Coordinate controls, interlocks, wiring of pneumatic switches, and relays.

F. Coordinate wiring and control diagrams.

G. Review the effect of any changes on work of other Sections.

H. Verify and coordinate maintenance of Record Documents.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1.8 COORDINATION OF SUBSTITUTIONS AND MODIFICATIONS

A. Review proposals and requests from subcontractors.

B. Certify in writing compliance with Contract Documents coordination drawings, and for compatibility with Work and Products of other Sections.

1.9 OBSERVATION OF WORK

A. Observe Work for compliance with Contract Documents.

B. Maintain a list of observed deficiencies and defects; promptly submit to Contractor. Contractor shall forward list to Engineer.

1.10 DOCUMENTATION

A. Observe and maintain a record of tests. Record:
1. Specification Section number, product, and name of manufacturer.
2. Testing agency and name of inspector.
3. Name of manufacturer=s representative present.
4. Date, time, and duration of tests.
5. Type of test and results.
6. Retesting required.

B. Submit copies of documentation to Engineer written three (3) days after observation of record test.

1.11 EQUIPMENT START-UP

A. Verify utilities, connections, instrumentation, and controls are complete. Certify in writing that work is complete and equipment is in operable condition as required by Division 01 Section “Start-Up Procedures”.

B. Observe start-up and adjustments; record time and date of start-up and results.

C. Observe equipment demonstrations to Owner; record times and additional information required for Operation and Maintenance Manuals.

D. Provide written report of the start-up to the Engineer within two (2) days.

1.12 INSPECTION AND ACCEPTANCE OF WORK

A. Prior to inspection, verify in writing that equipment is tested, operational, and clean.

B. Assist Engineer with inspection. Prepare list of items to be completed and corrected prior to Engineer's list.

C. Provide written verification that all appropriate shop drawings and Operation and Maintenance Manuals have been submitted and accepted.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

D. Provide written verification that equipment training has been provided as required in Division 01 Section “Demonstration and Training”.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:
   1. Preliminary Construction Schedule.
   2. Contractor's Construction Schedule.
   3. Submittals Schedule.
   4. Daily construction reports.
   5. Material location reports.
   6. Field condition reports.
   7. Special reports.

B. Related Sections include the following:
   1. Division 01 Section "Payment Procedures" for submitting the Schedule of Values.
   2. Division 01 Section "Project Management and Coordination" for submitting and distributing meeting and conference minutes.
   3. Division 01 Section "Submittal Procedures" for submitting schedules and reports.
   4. Division 01 Section "Construction Progress Documentation" for submitting construction documentation.
   5. Division 01 Section "Quality Requirements" for submitting a schedule of tests and inspections.

1.3 DEFINITIONS

A. Activity: A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the construction project. Activities included in a construction schedule consume time and resources.
   1. Critical activities are activities on the critical path. They must start and finish on the planned early start and finish times.
   2. Predecessor Activity: An activity that precedes another activity in the network.
   3. Successor Activity: An activity that follows another activity in the network.

B. Cost Loading: The allocation of the Schedule of Values for the completion of an activity as scheduled. The sum of costs for all activities must equal the total Contract Sum, unless otherwise approved by the Engineer.

C. CPM: Critical path method, which is a method of planning and scheduling a construction project where activities are arranged based on activity relationships. Network calculations determine when activities can be performed and the critical path of Project.

D. Critical Path: The longest connected chain of interdependent activities through the network schedule that establishes the minimum overall Project duration and contains no float.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

E. Event: The starting or ending point of an activity.

F. Float: The measure of leeway in starting and completing an activity.
   1. Float time is not for the exclusive use or benefit of either Owner or Contractor, but is a jointly owned, expiring Project resource available to both parties as needed to meet schedule milestones and Contract completion date.
   2. Free float is the amount of time an activity can be delayed without adversely affecting the early start of the successor activity.
   3. Total float is the measure of leeway in starting or completing an activity without adversely affecting the planned Project completion date.

G. Fragnet: A partial or fragmentary network that breaks down activities into smaller activities for greater detail.

H. Major Area: A story of construction, a separate building, or a similar significant construction element.

I. Milestone: A key or critical point in time for reference or measurement.

J. Network Diagram: A graphic diagram of a network schedule, showing activities and activity relationships.

K. Resource Loading: The allocation of manpower and equipment necessary for the completion of an activity as scheduled.

1.4 SUBMITTALS

A. Qualification Data: For scheduling consultant.

B. Submittals Schedule: Submit three copies of schedule. Arrange the following information in a tabular format:
   1. Scheduled date for first submittal.
   2. Specification Section number and title.
   3. Submittal category (action or informational).
   4. Name of subcontractor.
   5. Description of the Work covered.
   6. Scheduled date for Engineer's final release or approval.
   7. Required mock-ups.

C. Preliminary Construction Schedule: Submit two opaque copies.
   1. Approval of cost-loaded preliminary construction schedule will not constitute approval of Schedule of Values for cost-loaded activities.

D. Preliminary Network Diagram: Submit two opaque copies, large enough to show entire network for entire construction period. Show logic ties for activities.

E. Contractor's Construction Schedule: Submit two opaque copies of initial schedule, large enough to show entire schedule for entire construction period.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

F. CPM Reports: Concurrent with CPM schedule, submit three copies of each of the following computer-generated reports. Format for each activity in reports shall contain activity number, activity description, cost and resource loading, original duration, remaining duration, early start date, early finish date, late start date, late finish date, and total float in calendar days.
   1. Activity Report: List of all activities sorted by activity number and then early start date, or actual start date if known.
   2. Logic Report: List of preceding and succeeding activities for all activities, sorted in ascending order by activity number and then early start date, or actual start date if known.
   3. Total Float Report: List of all activities sorted in ascending order of total float.
   4. Earnings Report: Compilation of Contractor's total earnings from the Notice to Proceed until most recent Application for Payment.

G. Daily Construction Reports: Submit two copies at weekly intervals.

H. Material Location Reports: Submit two copies at weekly intervals.

I. Field Condition Reports: Submit two copies at time of discovery of differing conditions.

J. Special Reports: Submit two copies at time of unusual event.

1.5 QUALITY ASSURANCE

A. Scheduling Consultant Qualifications: An experienced specialist in CPM scheduling and reporting, with capability of producing CPM reports and diagrams within 24 hours of Engineer's request.

1.6 COORDINATION

A. Coordinate preparation and processing of schedules and reports with performance of construction activities and with scheduling and reporting of separate contractors.

B. Coordinate Contractor's Construction Schedule with the Schedule of Values, list of subcontracts, Submittals Schedule, progress reports, payment requests, and other required schedules and reports.
   1. Secure time commitments for performing critical elements of the Work from parties involved.
   2. Coordinate each construction activity in the network with other activities and schedule them in proper sequence.

PART 2 - PRODUCTS

2.1 SUBMITTALS SCHEDULE

A. Preparation: Submit a schedule of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, resubmittal, ordering, manufacturing, fabrication, and delivery when establishing dates.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1. Coordinate Submittals Schedule with list of subcontracts, the Schedule of Values, and Contractor's Construction Schedule.
2. Initial Submittal: Submit concurrently with bar-chart schedule. Include submittals required during the first 60 days of construction. List those required to maintain orderly progress of the Work and those required early because of long lead time for manufacture or fabrication.
    a. At Contractor's option, show submittals on the Preliminary Construction Schedule, instead of tabulating them separately.
3. Final Submittal: Submit concurrently with the first complete submittal of Contractor's Construction Schedule.

2.2 CONTRACTOR'S CONSTRUCTION SCHEDULE, GENERAL

A. Procedures: Comply with procedures contained in AGC's "Construction Planning & Scheduling."

B. Time Frame: Extend schedule from date established for the Notice to Proceed to date of Substantial Completion.
1. Contract completion date shall not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.

C. Activities: Treat each story or separate area as a separate numbered activity for each principal element of the Work. Comply with the following:
1. Activity Duration: Define activities so no activity is longer than 20 days, unless specifically allowed by Engineer.
2. Procurement Activities: Include procurement process activities for the following long lead items and major items, requiring a cycle of more than 60 days, as separate activities in schedule. Procurement cycle activities include, but are not limited to, submittals, approvals, purchasing, fabrication, and delivery.
3. Submittal Review Time: Include review and resubmittal times indicated in Division 01 Section "Submittal Procedures" in schedule. Coordinate submittal review times in Contractor's Construction Schedule with Submittals Schedule.
4. Startup and Testing Time: Include not less than three days for startup and testing.
5. Substantial Completion: Indicate completion in advance of date established for Substantial Completion, and allow time for Engineer's and Construction Manager's administrative procedures necessary for certification of Substantial Completion.

D. Constraints: Include constraints and work restrictions indicated in the Contract Documents and as follows in schedule; show how the sequence of Work is affected.
1. Phasing: Arrange list of activities on schedule by phase.
2. Work by Owner: Include a separate activity for each portion of the Work performed by Owner.
3. Owner-Furnished Products/Equipment: Include a separate activity for each product/equipment. Include delivery date indicated in Division 01 Section "Summary." Delivery dates indicated stipulate earliest possible delivery date.
4. Work Restrictions: Show the effect of the following items on the schedule:
    a. Coordination with existing construction.
    b. Limitations of continued occupancies.
    c. Uninterruptible services.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

d. Partial occupancy before Substantial Completion.
e. Use of premises restrictions.
f. Provisions for future construction.
g. Seasonal variations.
h. Environmental control.

5. Work Stages: Indicate important stages of construction for each major portion of the Work, including, but not limited to, the following:
   a. Subcontract awards.
   b. Submittals.
   c. Purchases.
   d. Mockups.
   e. Fabrication.
   f. Sample testing.
   g. Deliveries.
   h. Installation.
   i. Tests and inspections.
   j. Adjusting.
   k. Curing.
   l. Training and demonstration.
   m. Startup and placement into final use and operation.
6. Area Separations: Identify each major area of construction for each major portion of the Work. Indicate where each construction activity within a major area must be sequenced or integrated with other construction activities to provide for the following:
   a. Structural completion.
   b. Permanent space enclosure.
   c. Completion of mechanical installation.
   d. Completion of electrical installation.
   e. Substantial Completion.

E. Milestones: Include milestones indicated in the Contract Documents in schedule, including, but not limited to, the Notice to Proceed, Substantial Completion, and Final Completion.

F. Cost Correlation: At the head of schedule, provide a cost correlation line, indicating planned and actual costs. On the line, show dollar volume of the Work performed as of dates used for preparation of payment requests.
   1. Refer to Division 01 Section "Payment Procedures" for cost reporting and payment procedures.
   2. Contractor shall assign cost to construction activities on the CPM schedule. Costs shall not be assigned to submittal activities unless specified otherwise but may, with Engineer's approval, be assigned to fabrication and delivery activities. Costs shall be under required principal subcontracts for testing and commissioning activities, operation and maintenance manuals, punch list activities, Project Record Documents, and demonstration and training (if applicable), in the amount of 5 percent of the Contract Sum.
   3. Each activity cost shall reflect an accurate value subject to approval by Engineer.
   4. Total cost assigned to activities shall equal the total Contract Sum.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

G. Contract Modifications: For each proposed contract modification and concurrent with its submission, prepare a time-impact analysis using fragments to demonstrate the effect of the proposed change on the overall project schedule.

H. Computer Software: Prepare schedules using a program that has been developed specifically to manage construction schedules.
   1. Primavera, latest version, or Engineer-approved alternative.

2.3 PRELIMINARY CONSTRUCTION SCHEDULE

A. Bar-Chart Schedule: Submit preliminary horizontal bar-chart-type construction schedule within seven days of date established for the Notice to Proceed.

B. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line. Outline significant construction activities for first 60 days of construction. Include skeleton diagram for the remainder of the Work and a cash requirement prediction based on indicated activities.

2.4 CONTRACTOR'S CONSTRUCTION SCHEDULE (GANTT CHART)

A. Gantt-Chart Schedule: Submit a comprehensive, fully developed, horizontal Gantt-chart-type, Contractor's Construction Schedule within 30 days of date established for the Notice to Proceed. Base schedule on the Preliminary Construction Schedule and whatever updating and feedback was received since the start of Project.

B. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line.
   1. For construction activities that require 3 months or longer to complete, indicate an estimated completion percentage in 10 percent increments within time bar.

2.5 CONTRACTOR'S CONSTRUCTION SCHEDULE (CPM SCHEDULE)

A. General: Prepare network diagrams using AON (activity-on-node) format.

B. Preliminary Network Diagram: Submit diagram within 14 days of date established for the Notice to Proceed. Outline significant construction activities for the first 60 days of construction. Include skeleton diagram for the remainder of the Work and a cash requirement prediction based on indicated activities.

C. CPM Schedule: Prepare Contractor's Construction Schedule using a computerized, cost-loaded, time-scaled CPM network analysis diagram for the Work.
   1. Develop network diagram in sufficient time to submit CPM schedule so it can be accepted for use no later than 30 days after date established for the Notice to Proceed.
      a. Failure to include any work item required for performance of this Contract shall not excuse Contractor from completing all work within applicable completion dates, regardless of Architect's approval of the schedule.
   2. Conduct educational workshops to train and inform key Project personnel, including subcontractors' personnel, in proper methods of providing data and using CPM schedule information.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3. Establish procedures for monitoring and updating CPM schedule and for reporting progress. Coordinate procedures with progress meeting and payment request dates.
4. Use "one workday" as the unit of time. Include list of nonworking days and holidays incorporated into the schedule.

D. CPM Schedule Preparation: Prepare a list of all activities required to complete the Work. Using the preliminary network diagram, prepare a skeleton network to identify probable critical paths.
1. Activities: Indicate the estimated time duration, sequence requirements, and relationship of each activity in relation to other activities. Include estimated time frames for the following activities:
    a. Preparation and processing of submittals.
    b. Mobilization and demobilization.
    c. Purchase of materials.
    d. Delivery.
    e. Fabrication.
    f. Utility interruptions.
    g. Installation.
    h. Work by Owner that may affect or be affected by Contractor's activities.
    i. Testing and commissioning.
2. Critical Path Activities: Identify critical path activities, including those for interim completion dates. Scheduled start and completion dates shall be consistent with Contract milestone dates.
3. Processing: Process data to produce output data on a computer-drawn, time-scaled network. Revise data, reorganize activity sequences, and reproduce as often as necessary to produce the CPM schedule within the limitations of the Contract Time.
4. Format: Mark the critical path. Locate the critical path near center of network; locate paths with most float near the edges.
    a. Subnetworks on separate sheets are permissible for activities clearly off the critical path.

E. Initial Issue of Schedule: Prepare initial network diagram from a list of straight "early start-total float" sort. Identify critical activities. Prepare tabulated reports showing the following:
1. Contractor or subcontractor and the Work or activity.
2. Description of activity.
3. Principal events of activity.
4. Immediate preceding and succeeding activities.
5. Early and late start dates.
6. Early and late finish dates.
7. Activity duration in workdays.
8. Total float or slack time.
9. Average size of workforce.
10. Dollar value of activity (coordinated with the Schedule of Values).

F. Schedule Updating: Concurrent with making revisions to schedule, prepare tabulated reports showing the following:
1. Identification of activities that have changed.
2. Changes in early and late start dates.
3. Changes in early and late finish dates.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

4. Changes in activity durations in workdays.
5. Changes in the critical path.
6. Changes in total float or slack time.
7. Changes in the Contract Time.

G. Value Summaries: Prepare two cumulative value lists, sorted by finish dates.
1. In first list, tabulate activity number, early finish date, dollar value, and cumulative dollar value.
2. In second list, tabulate activity number, late finish date, dollar value, and cumulative dollar value.
3. In subsequent issues of both lists, substitute actual finish dates for activities completed as of list date.
4. Prepare list for ease of comparison with payment requests; coordinate timing with progress meetings.
   a. In both value summary lists, tabulate "actual percent complete" and "cumulative value completed" with total at bottom.
   b. Submit value summary printouts one week before each regularly scheduled progress meeting.

2.6 REPORTS

A. Daily Construction Reports: Prepare a daily construction report recording the following information concerning events at Project site:
1. List of subcontractors at Project site.
2. List of separate contractors at Project site.
3. Approximate count of personnel at Project site.
4. Equipment at Project site.
5. Material deliveries.
6. High and low temperatures and general weather conditions.
7. Accidents.
8. Meetings and significant decisions.
9. Unusual events (refer to special reports).
10. Stoppages, delays, shortages, and losses.
11. Meter readings and similar recordings.
12. Emergency procedures.
13. Orders and requests of authorities having jurisdiction.
14. Change Orders received and implemented.
15. Work Change Directives received and implemented.
16. Services connected and disconnected.
17. Equipment or system tests and startups.
18. Partial Completions and occupancies.
19. Substantial Completions authorized.

B. Material Location Reports: At monthly intervals, prepare and submit a comprehensive list of materials delivered to and stored at Project site. List shall be cumulative, showing materials previously reported plus items recently delivered. Include with list a statement of progress on and delivery dates for materials or items of equipment fabricated or stored away from Project site.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

C. Field Condition Reports: Immediately on discovery of a difference between field conditions and the Contract Documents, prepare and submit a detailed report. Submit with a request for interpretation. Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents.

2.7 SPECIAL REPORTS

A. General: Submit special reports directly to Owner and Engineer within one day of an occurrence. Distribute copies of report to parties affected by the occurrence.

B. Reporting Unusual Events: When an event of an unusual and significant nature occurs at Project site, whether or not related directly to the Work, prepare and submit a special report. List chain of events, persons participating, response by Contractor's personnel, evaluation of results or effects, and similar pertinent information. Advise Owner in advance when these events are known or predictable.

PART 3 - EXECUTION

3.1 CONTRACTOR'S CONSTRUCTION SCHEDULE

A. Scheduling Consultant: Engage a consultant to provide planning, evaluation, and reporting using CPM scheduling.
   1. In-House Option: Owner may waive the requirement to retain a consultant if Contractor employs skilled personnel with experience in CPM scheduling and reporting techniques. Submit qualifications.
   2. Meetings: Scheduling consultant shall attend all meetings related to Project progress, alleged delays, and time impact.

B. Contractor's Construction Schedule Updating: At monthly intervals, update schedule to reflect actual construction progress and activities. Issue schedule one week before each regularly scheduled progress meeting.
   1. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with the report of each such meeting.
   2. Include a report with updated schedule that indicates every change, including, but not limited to, changes in logic, durations, actual starts and finishes, and activity durations.
   3. As the Work progresses, indicate Actual Completion percentage for each activity.

C. Distribution: Distribute copies of approved schedule to Engineer, Owner, separate contractors, testing and inspecting agencies, and other parties identified by Contractor with a need-to-know schedule responsibility.
   1. Post copies in Project meeting rooms and temporary field offices.
   2. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes administrative and procedural requirements for the following:
   1. Periodic construction photographs.

B. Related Sections include the following:
   1. Division 01 Section "Construction Progress Documentation" for photographic documentation before building demolition operations commences.

1.3 SUBMITTALS

A. Construction Photographs: Submit two color prints at a minimum of three photographic views depicting progress of the Work in each area of the Project. Coordinate the photographic views for each area with the resident Project Representative. Up to 36 prints may be required per month.
   1. Format: 8-by-10-inch(203-by-254-mm) smooth-surface matte prints on single-weight commercial-grade photographic paper or on equal quality color printer paper.
   2. Identification: On back of each print provide an applied label or rubber-stamped impression with the following information:
      a. Name of Project.
      b. Name and address of photographer.
      c. Name of Engineer.
      d. Name of Contractor.
      e. Date photograph was taken if not date stamped by camera.
      f. Description of vantage point, indicating location, direction (by compass point), and description of construction.
   3. Digital Images: Submit a complete set of digital image electronic files with each submittal of prints on CD-ROM. Identify electronic media with date photographs were taken. Submit images that have same aspect ratio as the sensor, uncropped.

PART 2 - PRODUCTS

2.1 PHOTOGRAPHIC MEDIA

A. Digital Images: Provide images in JPEG format, produced by a digital still camera with a minimum of 10.2 M effective pixels and a minimum number of recorded pixels equal to 3,872 x 2.592 (IOM).

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 3 - EXECUTION

3.1 CONSTRUCTION PHOTOGRAPHS

A. General: Take photographs using the maximum range of depth of field, and that are in focus, to clearly show the Work. Photographs with blurry or out-of-focus areas will not be accepted.

B. Film Images:
   1. Date Stamp: Unless otherwise indicated, date and time stamp each photograph as it is being taken so stamp is integral to photograph.

C. Digital Images: Submit digital images exactly as originally recorded in the digital camera, without alteration, manipulation, editing, or modifications using image-editing software.
   1. Date and Time: Include date and time in filename for each image.

D. Periodic Construction Photographs: Take color digital photographs monthly, coinciding with the cutoff date associated with each Application for Payment. Select vantage points to show status of construction and progress since last photographs were taken.

E. Following substantial completion of the Project, arrange for aerial color digital photographs of the plant site. Schedule with approval from the Engineer. Provide at a minimum photographs taken from the four major compass points (N, E, S, and W). Include a portion of the river in each photograph showing the outfall area. Provide a CD-Rom disc with all photographs taken by the aerial photographer.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other miscellaneous submittals.

B. Related Sections include the following:
   1. Division 01 Section “Payment Procedures” for submitting Application for Payment.
   2. Division 01 Section “Construction Progress Documentation” for submitting schedules and reports, including Contractor’s Construction Schedule.
   3. Division 01 Section “Closeout Procedures” for submitting warranties and Project Record Documents.
   4. Division 01 Section “Project Record Documents” for submitting Record Drawings, Record Specifications, and Record Product Data.
   5. Division 01 Section "Operation and Maintenance Data" for submitting operation and maintenance manuals.

1.3 DEFINITIONS

A. Action Submittals: Written and graphic information that requires Engineer's responsive action.

B. Informational Submittals: Written information that does not require Engineer's approval. Submittals may be rejected for not complying with requirements.

1.4 SUBMITTAL PROCEDURES

A. General: Electronic copies of base plans of the Contract Drawings for Contractor's use in preparing submittals will not be provided.

B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.
   1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
   2. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.
      a. Engineer reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.

C. Processing Time: Allow enough time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Engineer's receipt of submittal.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1. Initial Review: Allow 15 days for initial review of each submittal. Allow additional time if processing must be delayed to permit coordination with subsequent submittals. Owner will advise Contractor when a submittal being processed must be delayed for coordination.
2. If resubmittal is necessary, process it in same manner as initial submittal.
3. Allow 15 days for processing each resubmittal.
4. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing.
5. Submittals out of sequence from agreed upon schedule may result in back charges to the Contractor.

D. Identification: Place a permanent label, title block, or standard cover sheet on each submittal for identification.
1. Indicate name of firm or entity that prepared each submittal on label or title block.
2. Provide a space on label or beside title block to record Contractor's review and approval markings.
3. Include the following information on label for processing and recording action taken:
   a. Project name.
   b. Date.
   c. Name and address of Contractor.
   d. Name and address of subcontractor.
   e. Name and address of supplier.
   f. Name of manufacturer.
   g. Unique identifier, including revision number.
   h. Number and title of appropriate Specification Section.
   i. Drawing number and detail references, as appropriate.
   j. Other necessary identification.

E. Deviations: Highlight, encircle, or otherwise identify deviations from the Contract Documents on submittals.

F. Transmittal: Package each submittal individually and appropriately for transmittal and handling. Transmit each submittal using a transmittal form. Engineer will return submittals, without review, received from sources other than Contractor.

G. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.
1. Note date and content of previous submittal.
2. Note date and content of revision in label or title block and clearly indicate extent of revision.
3. Resubmit submittals until they are marked “No Exceptions Noted” or “Exceptions Noted”.

H. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.

I. Use for Construction: Use only final submittals with mark indicating action taken by Engineer in connection with construction.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 2 - PRODUCTS

2.1 ACTION SUBMITTALS

A. General: Prepare and submit Action Submittals required by individual Specification Sections.

B. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.
   1. If information must be specially prepared for submittal because standard printed data are not suitable for use, submit as Shop Drawings, not as Product Data.
   2. Mark each copy of each submittal to show which products and options are applicable.
   3. Include the following information, as applicable:
      a. Manufacturer's written recommendations.
      b. Manufacturer's product specifications.
      c. Manufacturer's installation instructions.
      d. Manufacturer's catalog cuts.
      e. Wiring diagrams showing factory-installed wiring.
      f. Printed performance curves.
      g. Operational range diagrams.
      h. Mill reports.
      i. Standard product operating and maintenance manuals.
      j. Compliance with recognized trade association standards.
      k. Compliance with recognized testing agency standards.
      l. Application of testing agency labels and seals.
      m. Notation of coordination requirements.
   4. Number of Copies: Submit three copies to the Engineer, plus the number of copies the Contractor desires to have returned. Engineer will retain three copies.

C. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data.
   1. Electronic submittals will not be acceptable.
   2. Preparation: Include the following information, as applicable:
      a. Dimensions.
      b. Identification of products.
      c. Fabrication and installation drawings.
      d. Roughing-in and setting diagrams.
      e. Wiring diagrams showing field-installed wiring, including power, signal, and control wiring.
      f. Shopwork manufacturing instructions.
      g. Templates and patterns.
      h. Schedules.
      i. Design calculations.
      j. Compliance with specified standards.
      k. Notation of coordination requirements.
      l. Notation of dimensions established by field measurement.
   3. Wiring Diagrams: Differentiate between manufacturer-installed and field-installed wiring.
   4. Number of Copies: Submit eight copies of each submittal. Engineer will retain four copies; remainder will be returned.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

D. Samples: Prepare physical units of materials or products, including the following:
   1. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available.
   2. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from the same material to be used for the Work, cured and finished in manner specified, and physically identical with the product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.
   3. Preparation: Mount, display, or package Samples in manner specified to facilitate review of qualities indicated. Attach label on unexposed side that includes the following:
      a. Generic description of Sample.
      b. Product name or name of manufacturer.
      c. Sample source.
      d. Submit a single Sample where assembly details, workmanship, fabrication techniques, connections, operation, and other similar characteristics are to be demonstrated.
   4. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.

E. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products. Include the following information in tabular form:
   1. Name, address, and telephone number of entity performing subcontract or supplying products.
   2. Number and title of related Specification Section(s) covered by subcontract.
   3. Drawing number and detail references, as appropriate, covered by subcontract.

2.2 INFORMATIONAL SUBMITTALS

A. General: Prepare and submit Informational Submittals to Engineer required by other Specification Sections.
   1. Number of Copies: Submit five copies of each submittal, unless otherwise indicated. Engineer will not return copies.
   2. Certificates and Certifications: Provide a notarized statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.
   3. Test and Inspection Reports: Comply with requirements in Division 1 Section "Quality Requirements."

B. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, names and addresses of engineers and owners, and other information specified.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

C. Product Certificates: Prepare written statements on manufacturer's letterhead certifying that product complies with requirements.

D. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements. Submit record of Welding Procedure Specification (WPS) and Procedure Qualification Record (PQR) on AWS forms. Include names of firms and personnel certified.

E. Installer Certificates: Prepare written statements on manufacturer's letterhead certifying that Installer complies with requirements and, where required, is authorized for this specific Project.

F. Manufacturer Certificates: Prepare written statements on manufacturer's letterhead certifying that manufacturer complies with requirements. Include evidence of manufacturing experience where required.

G. Material Certificates: Prepare written statements on manufacturer's letterhead certifying that material complies with requirements.

H. Material Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements.

I. Preconstruction Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements.

J. Compatibility Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.

K. Field Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements.

L. Product Test Reports: Prepare written reports indicating current product produced by manufacturer complies with requirements. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.

M. Maintenance Data: Prepare written and graphic instructions and procedures for operation and normal maintenance of products and equipment. Comply with requirements in Division 01 Section "Operation and Maintenance Data".

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

N. Manufacturer's Instructions: Prepare written or published information that documents manufacturer's recommendations, guidelines, and procedures for installing or operating a product or equipment. Include name of product and name, address, and telephone number of manufacturer. Include the following, as applicable:
   1. Preparation of substrates.
   2. Required substrate tolerances.
   3. Sequence of installation or erection.
   4. Required installation tolerances.
   5. Required adjustments.
   6. Recommendations for cleaning and protection.

O. Manufacturer's Field Reports: Prepare written information documenting factory-authorized service representative's tests and inspections. Include the following, as applicable:
   1. Name, address, and telephone number of factory-authorized service representative making report.
   2. Statement on condition of substrates and their acceptability for installation of product.
   3. Statement that products at Project site comply with requirements.
   4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
   5. Results of operational and other tests and a statement of whether observed performance complies with requirements.
   6. Statement whether conditions, products, and installation will affect warranty.
   7. Other required items indicated in individual Specification Sections.

P. Insurance Certificates and Bonds: Prepare written information indicating current status of insurance or bonding coverage. Include name of entity covered by insurance or bond, limits of coverage, amounts of deductibles, if any, and term of the coverage.

PART 3 - EXECUTION

3.1 CONTRACTOR'S REVIEW

A. Review each submittal and check for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Engineer.

B. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include Project name and location, submittal number, Specification Section title and number, name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.

3.2 ENGINEER'S ACTION

A. General: Engineer will not review submittals that do not bear Contractor's approval stamp and will return them without action.
   1. Review of submittals by Engineer is only for the limited purpose of checking for conformance with information given and the design concept expressed in the Contract Documents.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2. Review of submittals by Engineer is not for purpose of determining the accuracy and completeness of dimensions and quantities, or substantiating installation instructions.

B. Action Submittals: Engineer will review each submittal, make marks to indicate corrections or modifications required, and return it. Engineer will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action taken, as follows:
   1. No Exceptions Noted: Where submittal is marked "No Exceptions Noted", the Work covered by the submittal may proceed provided it complies with the Contract Documents.
   2. Exceptions Noted: Where submittal is marked "Exceptions Noted", the Work covered by the submittal may proceed provided it complies with both Engineer's notations and corrections on the submittal and the Contract Documents.
   3. Exceptions Noted - Resubmit: Where the submittal is marked "Exceptions Noted – Resubmit", do not proceed with the Work covered by the submittal, including purchasing, fabrication, delivery, or other activity for the product submitted. Revise or prepare a new submittal according to Engineer's notations and corrections.
   4. Resubmit: Where the submittal is marked "Resubmit", do not proceed with the Work covered by the submittal. Prepare a new submittal for a product that complies with the Contract Documents.
   5. Information: Where the submittal is marked "Information", the Engineer is neither approving nor disapproving the information provided within the submittal. This indication may be placed upon design calculations from Contractor, schedules, installation procedures, standards or regulations, etc.

C. Submittals not required by the Contract Documents will not be reviewed and may be discarded.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes administrative and procedural requirements for quality assurance and quality control.

B. Testing and inspecting services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.
   1. Specific quality-assurance and quality-control requirements for individual construction activities are specified in the Sections that specify those activities. Requirements in those Sections may also cover production of standard products.
   2. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and quality-control procedures that facilitate compliance with the Contract Document requirements.
   3. Requirements for Contractor to provide quality-assurance and quality-control services required by Engineer, Owner, or authorities having jurisdiction are not limited by provisions of this Section.

C. Related Sections include the following:
   1. Division 01 Section "Construction Progress Documentation" for developing a schedule of required tests and inspections.
   2. Division 01 Section "Contract Modification Procedures" for Change Order requirements.
   3. Divisions 02 through 44 Sections for specific test and inspection requirements.

1.3 DEFINITIONS

A. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.

B. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Services do not include contract enforcement activities performed by Engineer.

C. Mockups: Full-size, physical assemblies that are constructed on-site. Mockups are used to verify selections made under sample submittals, to demonstrate aesthetic effects and, where indicated, qualities of materials and execution, and to review construction, coordination, testing, or operation; they are not Samples.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

D. Laboratory Mockups: Full-size, physical assemblies that are constructed at testing facility to verify performance characteristics.

E. Preconstruction Testing: Tests and inspections that are performed specifically for the Project before products and materials are incorporated into the Work to verify performance or compliance with specified criteria.

F. Product Testing: Tests and inspections that are performed by an NRTL, an NVLAP, or a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with industry standards.

G. Source Quality-Control Testing: Tests and inspections that are performed at the source, i.e., plant, mill, factory, or shop.

H. Field Quality-Control Testing: Tests and inspections that are performed on-site for installation of the Work and for completed Work.

I. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.

J. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, and similar operations.
   1. Using a term such as "carpentry" does not imply that certain construction activities must be performed by accredited or unionized individuals of a corresponding generic name, such as "carpenter." It also does not imply that requirements specified apply exclusively to trades-people of the corresponding generic name.

K. Experienced: When used with an entity, "experienced" means having successfully completed a minimum of five previous projects similar in size and scope to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

1.4 CONFLICTING REQUIREMENTS

A. General: If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer uncertainties and requirements that are different, but apparently equal, to Engineer for a decision before proceeding.

B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Engineer for a decision before proceeding.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1.5 SUBMITTALS

A. Qualification Data: For testing agencies specified in Part 1.6, "Quality Assurance" to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.

B. Schedule of Tests and Inspections: Prepare in tabular form and include the following:
   1. Specification Section number and title.
   2. Description of test and inspection.
   3. Identification of applicable standards.
   4. Identification of test and inspection methods.
   5. Number of tests and inspections required.
   6. Time schedule or time span for tests and inspections.
   7. Entity responsible for performing tests and inspections.
   8. Requirements for obtaining samples.
   9. Unique characteristics of each quality-control service.

C. Reports: Prepare and submit certified written reports that include the following:
   1. Date of issue.
   2. Project title and number.
   3. Name, address, and telephone number of testing agency.
   4. Dates and locations of samples and tests or inspections.
   5. Names of individuals making tests and inspections.
   6. Description of the Work and test and inspection method.
   7. Identification of product and Specification Section.
   8. Complete test or inspection data.
   9. Test and inspection results and an interpretation of test results.
   10. Record of temperature and weather conditions at time of sample taking and testing and inspecting.
   11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
   12. Name and signature of laboratory inspector.
   13. Recommendations on retesting and reinspecting.

D. Permits, Licenses, and Certificates: For Engineer's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents, established for compliance with standards and regulations bearing on performance of the Work.

1.6 QUALITY ASSURANCE

A. General: Qualification requirements in this paragraph establish the minimum qualification levels required; individual Specification Sections specify additional requirements.

B. Installer Qualifications: A firm or individual experienced in installing, erecting, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

C. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

D. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice and maintains current licensure in the State of Kentucky, and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or products that are similar to those indicated for this Project in material, design, and extent.

F. Specialists: Certain sections of the Specifications require that specific construction activities shall be performed by entities who are recognized experts in those operations. Specialists shall satisfy qualification requirements indicated and shall be engaged for the activities indicated.
   1. Requirement for specialists shall not supersede building codes and regulations governing the Work.

G. Testing Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspecting indicated, as documented according to ASTM E 548; and with additional qualifications specified in individual Sections; and where required by authorities having jurisdiction, that is acceptable to authorities.
   1. NRTL: A nationally recognized testing laboratory according to 29 CFR 1910.7.
   2. NVLAP: A testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program.

H. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

I. Preconstruction Testing: Where testing agency is indicated to perform preconstruction testing for compliance with specified requirements for performance and test methods, comply with the following:
   1. Contractor responsibilities include the following:
      a. Provide test specimens representative of proposed products and construction.
      b. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
      c. Provide sizes and configurations of test assemblies, mockups, and laboratory mockups to adequately demonstrate capability of products to comply with performance requirements.
      d. Build site-assembled test assemblies and mockups using installers who will perform same tasks for Project.
      e. Build laboratory mockups at testing facility using personnel, products, and methods of construction indicated for the completed Work.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

f. When testing is complete, remove test specimens, assemblies, mockups, and laboratory mockups; do not reuse products on Project.

2. Testing Agency Responsibilities: Submit a certified written report of each test, inspection, and similar quality-assurance service to Engineer, with copy to Contractor. Interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from the Contract Documents.

1.7 QUALITY CONTROL

A. Owner Responsibilities: Where quality-control services are indicated as Owner's responsibility, Contractor shall provide a list of qualified testing agencies to perform these services.
   1. Contractor shall furnish Owner with names, addresses, and telephone numbers of testing agencies and a description of types of testing and inspecting they are engaged to perform. Owner will select an agency for the respective task. If the agency is not acceptable to the Owner, the Contractor shall resubmit an acceptable agency.
   2. Payment for these services will be made directly by Owner.
   3. Costs for retesting and reinspecting construction that replaces or is necessitated by work that failed to comply with the Contract Documents will be charged to Contractor.

B. Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.
   1. Where services are indicated as Contractor's responsibility, engage a qualified testing agency to perform these quality-control services.
      a. Contractor shall not employ same entity engaged by Owner, unless agreed to in writing by Owner.
   2. Notify testing agencies at least 48 hours in advance of time when Work that requires testing or inspecting will be performed.
   3. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
   4. Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
   5. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.

C. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Division 01 Section "Submittal Procedures."

D. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.

E. Testing Agency Responsibilities: Cooperate with Owner, Engineer, and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1. Notify Engineer and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
2. Determine the location from which test samples will be taken and in which in-situ tests are conducted.
3. Conduct and interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from requirements.
4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
6. Do not perform any duties of Contractor.

F. Associated Services: Cooperate with agencies performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:
1. Access to the Work.
2. Incidental labor and facilities necessary to facilitate tests and inspections.
3. Adequate quantities of representative samples of materials that require testing and inspecting. Assist agency in obtaining samples.
4. Facilities for storage and field-curing of test samples.
5. Delivery of samples to testing agencies.
6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
7. Security and protection for samples and for testing and inspecting equipment at Project site.

G. Coordination: Coordinate sequence of activities to accommodate required quality assurance and control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.
1. Schedule times for tests, inspections, obtaining samples, and similar activities.

H. Schedule of Tests and Inspections: Prepare a schedule of tests, inspections, and similar quality-control services required by the Contract Documents. Submit schedule within 30 days of date established for commencement of the Work.
1. Distribution: Distribute schedule to Owner, Engineer, testing agencies, and each party involved in performance of portions of the Work where tests and inspections are required.

1.8 SPECIAL TESTS AND INSPECTIONS

A. Special Tests and Inspections: Conducted by a qualified testing agency as required by authorities having jurisdiction, as indicated in individual Specification Sections, and as follows:
1. Verifying that manufacturer maintains detailed fabrication and quality-control procedures and reviewing the completeness and adequacy of those procedures to perform the Work.
2. Notifying Engineer and Contractor promptly of irregularities and deficiencies observed in the Work during performance of its services.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3. Submitting a certified written report of each test, inspection, and similar quality-control service to Engineer, with copy to Contractor and to authorities having jurisdiction.
4. Submitting a final report of special tests and inspections at Substantial Completion, that includes a list of unresolved deficiencies.
5. Interpreting tests and inspections and stating in each report whether tested and inspected work complies with or deviates from the Contract Documents.
6. Retesting and reinspecting corrected work.

1.9 PAYMENT FOR TESTING

A. Initial Services: Contractor shall schedule the services of all independent testing laboratories required to perform the inspections and tests specified in these documents. Payment for services shall be billed directly to the Owner.

B. Retesting: Should retesting be required to confirm non-compliance or confirm that reworked non-compliance items are now in compliance, Contractor shall pay for the testing.

C. Retesting at Engineer's Request: Should the Engineer request additional testing over and above the retesting required to confirm compliance, cost for the testing shall be the responsibility of the Contractor, should the additional testing confirm the non-compliance of an item. If the testing requested by the Engineer fails to confirm non-compliance, cost for the testing shall be the responsibility of the Owner.

D. Disputed Testing Results: Should the compliance of an item remain in dispute after retesting is complete, the Contractor shall coordinate obtaining the services of a second laboratory to test the disputed item. Should the testing results or observations obtained from the second laboratory confirm the item in question is not in compliance, the Contractor shall pay all costs for the additional testing effort performed by second laboratory. Should the results/observations provided by the second laboratory confirm the item in question is in compliance, the Owner shall pay for the second laboratory's testing/observation effort.

E. Contractor's Convenience Testing:
   1. Inspecting and testing performed exclusively for the Contractor's convenience shall be the sole responsibility of the Contractor.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TEST AND INSPECTION LOG

A. Prepare a record of tests and inspections. Include the following:
   1. Date test or inspection was conducted.
   2. Description of the Work tested or inspected.
   3. Date test or inspection results were transmitted to Engineer.
   4. Identification of testing agency or special inspector conducting test or inspection.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Maintain log at Project site. Post changes and modifications as they occur. Provide access to test and inspection log for Engineer's reference during normal working hours.

3.2 REPAIR AND PROTECTION

A. General: On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.
   1. Provide materials and comply with installation requirements specified in other Specification Sections. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible.

B. Protect construction exposed by or for quality-control service activities.

C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 DEFINITIONS

A. General: Basic Contract definitions are included in the Conditions of the Contract.

B. "Approved": When used to convey Engineer's action on Contractor's submittals, applications, and requests, "approved" is limited to Engineer's duties and responsibilities as stated in the Conditions of the Contract.

C. "Directed": A command or instruction by Engineer. Other terms including "requested," "authorized," "selected," "approved," "required," and "permitted" have the same meaning as "directed."

D. "Indicated": Requirements expressed by graphic representations or in written form on Drawings, in Specifications, and in other Contract Documents. Other terms including "shown," "noted," "scheduled," and "specified" have the same meaning as "indicated."

E. "Regulations": Laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, and rules, conventions, and agreements within the construction industry that control performance of the Work.

F. "Furnish": Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.

G. "Install": Operations at Project site including unloading, temporarily storing, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.

H. "Provide": Furnish and install, complete and ready for the intended use.

I. "Project Site": Space available for performing construction activities. The extent of Project site is shown on Drawings and may or may not be identical with the description of the land on which Project is to be built.

1.3 INDUSTRY STANDARDS

A. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.

B. Publication Dates: Comply with standards in effect as of date of the Contract Documents, unless otherwise indicated.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

C. Copies of Standards: Each entity engaged in construction on Project should be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.
   1. Where copies of standards are needed to perform a required construction activity, obtain copies directly from publication source.

1.4 ABBREVIATIONS AND ACRONYMS

A. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. Names, telephone numbers, and Web site addresses are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

AA	Aluminum Association, Inc. (The) www.aluminum.org	(202) 862-5100
AASHTO	American Association of State Highway and Transportation Officials www.transportation .org	(202) 624-5800
ACI	ACI International (American Concrete Institute) www.aci-int.org	(248) 848-3700
ACPA	American Concrete Pipe Association www.concrete-pipe.org	(972) 506-7216
AGA	American Gas Association www.aga.org	(202) 824-7000
AI	Asphalt Institute www.asphaltinstitute.org	(859) 288-4960
AISC	American Institute of Steel Construction www.aisc.org	(800) 644-2400 (312) 670-2400
AISI	American Iron and Steel Institute www.steel.org	(202) 452-7100
ANSI	American National Standards Institute www.ansi.org	(202) 293-8020
AOSA	Association of Official Seed Analysts www.aosaseed.com	(505) 522-1437
APA	Architectural Precast Association www.archprecast.org	(239) 454-6989
ASCE	American Society of Civil Engineers www.asce.org	(800) 548-2723 (703) 295-6300

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers www.ashrae.org	(800) 527-4723 (404) 636-8400
ASME	ASME International (The American Society of Mechanical Engineers International) www.asme.org	(800) 843-2763 (212) 591-7722
ASSE	American Society of Sanitary Engineering www.asse-plumbing.org	(440) 835-3040
ASTM	ASTM International (American Society for Testing and Materials International) www.astm.org	(610) 832-9585
AWS	American Welding Society www.aws.org	(800) 443-9353 (305) 443-9353
AWWA	American Water Works Association www.awwa.org	(800) 926-7337 (303) 794-7711
CDA	Copper Development Association Inc. www.copper.org	(800) 232-3282 (212) 251-7200
CGA	Compressed Gas Association www.cganet.com	(703) 788-2700
CLFMI	Chain Link Fence Manufacturers Institute www.chainlinkinfo.org	(301) 596-2583
CPPA	Corrugated Polyethylene Pipe Association www.cppa-info.org	(800) 510-2772 (202) 462-9607
CRSI	Concrete Reinforcing Steel Institute www.crsi.org	(847) 517-1200
CSI	Construction Specifications Institute (The) www.csinet.org	(800) 689-2900 (703) 684-0300
EJCDC	Engineers Joint Contract Documents Committee www.asce.org	(800) 548-2723 (703) 295-6300
EJMA	Expansion Joint Manufacturers Association, Inc. www.ejma.org	(914) 332-0040
FCI	Fluid Controls Institute www.fluidcontrolsinstitute.org	(216) 241-7333
FM	Factory Mutual System (See FMG)	
FMG	FM Global (Formerly: FM - Factory Mutual System) www.fmglobal.com	(401) 275-3000

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

FSA	Fluid Sealing Association www.fluidsealing.com	(610) 971-4850
GRI	Geosynthetic Research Institute (See GSI)	
GSI	Geosynthetic Institute www.geosynthetic-institute.org	(610) 522-8440
HI	Hydraulic Institute www.pumps.org	(888) 786-7744 (973) 267-9700
HI	Hydronics Institute www.gamanet.org	(908) 464-8200
IEEE	Institute of Electrical and Electronics Engineers, Inc. (The) www.ieee.org	(212) 419-7900
ISO	International Organization for Standardization www.iso.ch	41 22 749 01 11
LPI	Lightning Protection Institute www.lightning.org	(800) 488-6864 (847) 577-7200
MBMA	Metal Building Manufacturers Association www.mbma.com	(216) 241-7333
MSS	Manufacturers Standardization Society of The Valve and Fittings Industry Inc. www.mss-hq.com	(703) 281-6613
NACE	NACE International (National Association of Corrosion Engineers International) www.nace.org	(281) 228-6200
NCMA	National Concrete Masonry Association www.ncma.org	(703) 713-1900
NCPI	National Clay Pipe Institute www.ncpi.org	(262) 248-9094
NEMA	National Electrical Manufacturers Association www.nema.org	(703) 841-3200
NFPA	NFPA www.nfpa.org	(800) 344-3555 (617) 770-3000
NRMCA	National Ready Mixed Concrete Association www.nrmca.org	(888) 846-7622 (301) 587-1400
NSF	NSF International (National Sanitation Foundation International) www.nsf.org	(800) 673-6275 (734) 769-8010

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

NSSGA	National Stone, Sand & Gravel Association www.nssga.org	(800) 342-1415 (703) 525-8788
PCI	Precast/Prestressed Concrete Institute www.pci.org	(312) 786-0300
SAE	SAE International www.sae.org	(724) 776-4841
SPI/SPFD	Society of the Plastics Industry, Inc. (The) Spray Polyurethane Foam Division (See SPFA)	
SSPC	SSPC: The Society for Protective Coatings www.sspc.org	(877) 281-7772 (412) 281-2331
STI	Steel Tank Institute www.steeltank.com	(847) 438-8265
SWRI	Sealant, Waterproofing, & Restoration Institute www.swrionline.org	(816) 472-7974
TMS	The Masonry Society www.masonrysociety.org	(303) 939-9700
UL	Underwriters Laboratories Inc. www.ul.com	(800) 285-4476 (847) 272-8800
UNI	Uni-Bell PVC Pipe Association www.uni-bell.org	(972) 243-3902
WASTEC	Waste Equipment Technology Association www.wastec.org	(800) 424-2869 (202) 244-4700

B. Code Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. Names, telephone numbers, and Web site addresses are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

BOCA	BOCA International, Inc. (See ICC)	
CABO	Council of American Building Officials (See ICC)	
IAPMO	International Association of Plumbing and Mechanical Officials www.iapmo.org	(909) 472-4100
ICBO	International Conference of Building Officials (See ICC)	
ICBO ES	ICBO Evaluation Service, Inc. (See ICC-ES)	
ICC	International Code Council (Formerly: CABO - Council of American Building Officials) www.iccsafe.org	(703) 931-4533

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

ICC-ES	ICC Evaluation Service, Inc. www.icc-es.org	(800) 423-6587 (562) 699-0543
SBCCI	Southern Building Code Congress International, Inc. (See ICC)	

C. Federal Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. Names, telephone numbers, and Web site addresses are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

CE	Army Corps of Engineers www.usace.army.mil	
EPA	Environmental Protection Agency www.epa.gov	(202) 272-0167
FAA	Federal Aviation Administration www.faa.gov	(202) 366-4000
HUD	Department of Housing and Urban Development www.hud.gov	(202) 708-1112
OSHA	Occupational Safety & Health Administration www.osha.gov	(800) 321-6742 (202) 693-1999
RUS	Rural Utilities Service (See USDA)	(202) 720-9540
USDA	Department of Agriculture www.usda.gov	(202) 720-2791
USPS	Postal Service www.usps.com	(202) 268-2000

D. State Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. Names, telephone numbers, and Web site addresses are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

Kentucky		
EPPC	Kentucky Environmental and Public Protection Cabinet www.environment.ky.gov	(502) 564-3350

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This section specifies the requirements for uncovering and correction of work.

1.3 UNCOVERING OF WORK

A. If the Contract Documents, laws, ordinances, rules, regulations or orders of any Public Authority having jurisdiction require any portion of the Work to be inspected, provide the Engineer timely notice of its readiness so that the Engineer may observe such inspections.

B. If a portion of the Work is covered contrary to the Engineer's request or to requirements specifically expressed in the Contract Documents, it must, if required in writing by the Engineer, be uncovered for the Engineer's observation and be replaced at the Contractor's expense without change in the Contract Time.

C. If a portion of the Work has been covered which the Engineer has not specifically requested to observe prior to its being covered, the Engineer may request to see such Work and it shall be uncovered by the Contractor.
   1. If uncovered Work is in accordance with Contract Documents, costs of uncovering and replacement shall, by appropriate Change Order, be charged to the Owner.
   2. If uncovered Work is not in accordance with Contract Documents, the Contractor shall pay such costs unless the condition was caused by the Owner or a separate contractor in which event the Owner shall be responsible for payment of such costs.

1.4 CORRECTION OF WORK

A. Promptly correct the Work rejected by the Engineer or failing to conform to the requirements of the Contract Documents, whether observed before or after Substantial Completion and whether or not fabricated, installed or completed.
   1. Costs of correcting such rejected Work, including additional testing, inspections, and compensation for the Engineer's services and expenses made necessary thereby, shall be at the Contractor's expense.

B. The quality of materials and workmanship used in restoring this work shall be in full compliance with the requirements of the Contract Documents.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes requirements for temporary facilities and controls, including temporary utilities, support facilities, and security and protection facilities.

B. Temporary utilities include, but are not limited to, the following:
1. Sewers and drainage.
2. Water service and distribution.
3. Sanitary facilities, including toilets, wash facilities, and drinking-water facilities.
4. Heating and cooling facilities.
5. Ventilation.
6. Electric power service.
7. Lighting.
8. Telephone service.

C. Support facilities include, but are not limited to, the following:
1. Temporary roads and paving.
2. Dewatering facilities and drains.
3. Project identification and temporary signs.
4. Waste disposal facilities.
5. Storage and fabrication sheds.
6. Lifts and hoists.
7. Temporary stairs.
8. Construction aids and miscellaneous services and facilities.
9. Field offices.

D. Security and protection facilities include, but are not limited to, the following:
1. Environmental protection.
2. Stormwater control.
3. Dust control.
4. Tree and plant protection.
5. Site enclosure fence.
6. Security enclosure and lockup.
7. Barricades, warning signs, and lights.
8. Covered walkways.
9. Temporary enclosures.
10. Temporary partitions.
11. Fire protection.

E. Related Sections include the following:
1. Division 01 Section "Submittal Procedures" for procedures for submitting copies of implementation and termination schedule and utility reports.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2. Division 01 Section "Project Management and Coordination" for time constraints of temporary facilities and controls.
3. Division 31 Section "Site Excavation, Backfilling, and Compaction" for disposal of ground water at Project site.
4. Division 32 Section "Asphalt Paving" for construction and maintenance of asphalt paving for temporary roads and paved areas.

1.3 USE CHARGES

A. General: Cost or use charges for temporary facilities are not chargeable to Owner or Engineer and shall be included in the Contract Sum. Allow other entities to use temporary services and facilities without cost, including, but not limited to, the following:
   1. Owner's forces.
   2. Occupants of Project.
   3. Owner.
   4. Testing agencies.
   5. Personnel of authorities having jurisdiction.

B. Sewer Service: Pay sewer service use charges for sewer usage, by all parties engaged in construction, at Project site.

C. Water Service: Use water from Owner's existing water system after notification and approval by Owner. Provide connection and Owner-supplied metering and extensions of services as required for construction operations.

D. Electric Power Service: Pay electric power service use charges, whether metered or otherwise, for electricity used by all entities engaged in construction activities at Project site.

1.4 SUBMITTALS

A. Temporary Utility Reports: Submit reports of tests, inspections, meter readings, and similar procedures performed on temporary utilities.

B. Temporary Stormwater Best Management Practices: Submit practices to be installed per the Bowling Green, Kentucky Best Management Practices (BMP) Manual.

1.5 QUALITY ASSURANCE

A. Standards: Comply with ANSI A10.6, NECA's "Temporary Electrical Facilities," and NFPA 241.
   1. Trade Jurisdictions: Assigned responsibilities for installation and operation of temporary utilities are not intended to interfere with trade regulations and union jurisdictions.
   2. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.

B. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1.6 PROJECT CONDITIONS

A. Temporary Utilities: At earliest feasible time, when acceptable to Owner, change over from use of temporary service to use of permanent service.
   1. Temporary Use of Permanent Facilities: Installer of each permanent service shall assume responsibility for operation, maintenance, and protection of each permanent service during its use as a construction facility before Owner's acceptance, regardless of previously assigned responsibilities.

B. Conditions of Use: The following conditions apply to use of temporary services and facilities by all parties engaged in the Work:
   1. Keep temporary services and facilities clean and neat.
   2. Relocate temporary services and facilities as required by progress of the Work.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Provide new materials. Undamaged, previously used materials in serviceable condition may be used if approved by Owner**.** Provide materials suitable for use intended.

B. Pavement: Comply with Division 32 Section "Asphalt Paving."

C. Chain-Link Fencing: Minimum 2-inch(50-mm), 0.148-inch-(3.76-mm-) thick, galvanized steel, chain-link fabric fencing; minimum 6 feet(1.8 m) high with galvanized steel pipe posts; minimum 2-3/8-inch-(60-mm-) OD line posts and 2-7/8-inch-(73-mm-) OD corner and pull posts.

D. Tarpaulins: Fire-resistive labeled with flame-spread rating of 15 or less.

E. Water: Potable.

F. Stormwater Management: Comply with Bowling Green, Kentucky's BMP Manual.

2.2 TEMPORARY FACILITIES

A. Field Offices, General: Prefabricated or mobile units with serviceable finishes, temperature controls, and foundations adequate for normal loading.

B. Storage and Fabrication Sheds: Provide sheds sized, furnished, and equipped to accommodate materials and equipment for construction operations.
   1. Store combustible materials apart from building.

2.3 EQUIPMENT

A. General: Provide equipment suitable for use intended.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Fire Extinguishers: Hand carried, portable, UL rated. Provide class and extinguishing agent as indicated or a combination of extinguishers of NFPA-recommended classes for exposures.
   1. Comply with NFPA 10 and NFPA 241 for classification, extinguishing agent, and size required by location and class of fire exposure.

C. Self-Contained Toilet Units: Single-occupant units of chemical, aerated recirculation or combustion type; vented; fully enclosed with a glass-fiber-reinforced polyester shell or similar nonabsorbent material.

D. Heating Equipment: Provide vented, self-contained, liquid-propane-gas or fuel-oil heaters with individual space thermostatic control.
   1. Use of gasoline-burning space heaters, open-flame heaters, or salamander-type heating units is prohibited.
   2. Heating Units: Listed and labeled, by a testing agency acceptable to authorities having jurisdiction, marked for intended use for type of fuel being consumed.

E. Electrical Outlets: Properly configured, NEMA-polarized outlets to prevent insertion of 110- to 120-V plugs into higher-voltage outlets; equipped with ground-fault circuit interrupters, reset button, and pilot light.

2.4 PROJECT IDENTIFICATION AND SIGNS

A. Project identification sign is not required by the Project Funding Agency.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Locate facilities where they will serve Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required.

B. Provide each facility ready for use when needed to avoid delay. Maintain and modify as required. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

3.2 TEMPORARY UTILITY INSTALLATION

A. General: Engage appropriate local utility company to install temporary service or connect to existing service. Where utility company provides only part of the service, provide the remainder with matching, compatible materials and equipment. Comply with utility company recommendations.
   1. Arrange with utility company, Owner, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.
   2. Provide adequate capacity at each stage of construction. Before temporary utility is available, provide trucked-in services.
   3. Obtain easements to bring temporary utilities to Project site where Owner's easements cannot be used for that purpose.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Sanitary Facilities: Provide temporary toilets, wash facilities, and drinking-water fixtures. Comply with regulations and health codes for type, number, location, operation, and maintenance of fixtures and facilities.
   1. Disposable Supplies: Provide toilet tissue, paper towels, paper cups, and similar disposable materials for each facility. Maintain adequate supply. Provide covered waste containers for disposal of used material.
   2. Toilets: Install self-contained toilet units. Shield toilets to ensure privacy.

C. Heating and Cooling: Provide temporary heating and cooling required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of low temperatures or high humidity. Select equipment from that specified that will not have a harmful effect on completed installations or elements being installed.

D. Ventilation and Humidity Control: Provide temporary ventilation required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of high humidity. Select equipment from that specified that will not have a harmful effect on completed installations or elements being installed. Coordinate ventilation requirements to produce ambient condition required and minimize energy consumption.

E. Electric Power Service: Provide electric power service and distribution system of sufficient size, capacity, and power characteristics required for construction operations.
   1. Install electric power service overhead, unless otherwise indicated.

F. Lighting: Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.
   1. Install and operate temporary lighting that fulfills security and protection requirements without operating entire system.

G. Telephone Service: Provide temporary telephone service in common-use facilities for use by all construction personnel. Install one telephone line for each field office.
   1. Provide additional telephone lines for the following:
      a. Provide a dedicated telephone line for each facsimile machine and computer in each field office.
      b. Provide one telephone line for Engineer's and Owner's use.
   2. At each telephone, post a list of important telephone numbers.
      a. Police and fire departments.
      b. Ambulance service.
      c. Contractor's home office.
      d. Engineer's office.
      e. Owner's office.
      f. Principal subcontractors' field and home offices.
   3. Provide superintendent with cellular telephone or portable two-way radio for use when away from field office.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3.3 SUPPORT FACILITIES INSTALLATION

A. General: Comply with the following:
   1. Locate field offices, storage sheds, sanitary facilities, and other temporary construction and support facilities for easy access.

B. Traffic Controls: Provide temporary traffic controls at junction of temporary roads with public roads. Include warning signs for public traffic and "STOP" signs for entrance onto public roads. Comply with requirements of authorities having jurisdiction.

C. Storage and Fabrication Sheds: Provide sheds sized, furnished, and equipped to accommodate materials and equipment involved, including temporary utility services. Sheds may be open shelters or fully enclosed spaces within building or elsewhere on-site.

D. Parking: Provide temporary parking areas for construction personnel.

E. Dewatering Facilities and Drains: Comply with requirements of authorities having jurisdiction. Maintain Project site, excavations, and construction free of water.
   1. Dispose of rainwater in a lawful manner that will not result in flooding Project or adjoining properties nor endanger permanent Work or temporary facilities.

F. Temporary Signs: Provide signs as indicated on Drawings. Install signs where indicated to inform public and individuals seeking entrance to Project. Unauthorized signs are not permitted.

G. Waste Disposal Facilities: Provide waste-collection containers in sizes adequate to handle waste from construction operations. Comply with requirements of authorities having jurisdiction. Comply with Division 01 Section "Execution" for progress cleaning requirements.

3.4 SECURITY AND PROTECTION FACILITIES INSTALLATION

A. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction in ways and by methods that comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects. Avoid using tools and equipment that produce harmful noise. Restrict use of noisemaking tools and equipment to hours that will minimize complaints from persons or firms near Project site.

B. Stormwater Control: Provide earthen embankments, silt fences, check dams, and similar barriers in and around excavations and subgrade construction, sufficient to prevent flooding and siltation by runoff of stormwater from heavy rains. All stormwater controls shall meet the requirements of the Kentucky Division of Water.

C. Dust Control: Provide measures to stabilize soil from wind erosion and reduce dust generated by construction activities per BMP GHP-16 of the Bowling Green, Kentucky BMP Manual. This will be considered a temporary measure that will be utilized between initial disturbance and construction to reduce the amount of eroded material that could be exposed to rain impact.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

D. Tree and Plant Protection: Install temporary fencing located as indicated or outside the drip line of trees to protect vegetation from construction damage. Protect tree root systems from damage, flooding, and erosion.

E. Security Enclosure and Lockup: Install substantial temporary enclosure around partially completed areas of construction. Provide lockable entrances to prevent unauthorized entrance, vandalism, theft, and similar violations of security.

F. Barricades, Warning Signs, and Lights: Comply with standards and code requirements for erecting structurally adequate barricades. Paint with appropriate colors, graphics, and warning signs to inform personnel and public of possible hazard. Where appropriate and needed, provide lighting, including flashing red or amber lights.

G. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weathertight enclosure for building exterior.
   1. Where heating or cooling is needed and permanent enclosure is not complete, provide insulated temporary enclosures. Coordinate enclosure with ventilating and material drying or curing requirements to avoid dangerous conditions and effects.
   2. Vertical Openings: Close openings of 25 sq. ft. (2.3 sq. m) or less with plywood or similar materials.
   3. Horizontal Openings: Close openings in floor or roof decks and horizontal surfaces with load-bearing, wood-framed construction.
   4. Install tarpaulins securely using fire-retardant-treated wood framing and other materials.

3.5 OPERATION, TERMINATION, AND REMOVAL

A. Supervision: Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.

B. Maintenance: Maintain facilities in good operating condition until removal. Protect from damage caused by freezing temperatures and similar elements.
   1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.
   2. Prevent water-filled piping from freezing. Maintain markers for underground lines. Protect from damage during excavation operations.

C. Termination and Removal: Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.
   1. Materials and facilities that constitute temporary facilities are the property of Contractor.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes erosion prevention and sediment control measures for all excavation and other construction activities within the limits of the site, any temporary or permanent easements, and within any borrow or spoil areas used during the entire duration of construction.

1.3 QUALITY ASSURANCE

A. All erosion prevention and sediment control work shall comply with applicable requirements of governing authorities having jurisdiction and of the National Pollutant Discharge Elimination System (NPDES). Both the Storm Water Pollution Prevention Plan (SWPPP) and the Kentucky Pollutant Discharge Elimination System (KPDES) Permit have been prepared and will be available to the Contractor if necessary. These documents are not represented as being comprehensive, but rather convey the intent to provide complete erosion prevention and sediment control for the Owner's and adjacent properties. In the event of a discrepancy between these documents and requirements of authorities having jurisdiction, the more stringent of the two shall take precedence.

B. Erosion prevention and sediment control measures shall be provided prior to commencement of construction and diligently maintained for the entire duration of construction. On-site and off-site areas which are especially vulnerable to damage from erosion and sedimentation, are to be identified and receive special attention.

C. All land-disturbing activities shall be planned and conducted to minimize the area exposed at any one time and time of exposure; and to prevent discharge of sediment laden water from the site.

D. Surface water runoff originating upgrade of exposed areas shall be diverted to reduce erosion and sediment loss during the period of exposure.

E. The Contractor is responsible for removal of sediment from all erosion prevention and sediment control structures, barriers and ponds when capacity of the feature is reduced by one-half or as set forth in the SWPPP and/or by authorities having jurisdiction.

F. The Contractor is required to perform inspections and document conditions of erosion prevention and sediment control measures. Frequency of inspection shall be as set forth in the SWPPP and/or by authorities having jurisdiction. Maintenance shall be performed promptly.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Crushed stone for stabilized construction entrance/exit shall be KYTC No. 2 stone. Filter fabric for stabilized construction entrance/exit shall be Mirafi 135N or equivalent.

B. Silt fence shall be "Envirofence" preassembled silt fence by Mirafi, Inc., or equivalent.

C. Stone Filled Bags: Bags shall be of like material to silt fence. Stone shall be clean KYTC No. 57 crushed stone. Filled bags shall be at least 2 feet long, 1'-6" wide and 6 inches thick.

D. Rock for check dam structures shall be clean, small rip rap (2 to 15 inches in diameter).

E. Strawbales: Bales shall be either wire bound or string tied and placed with bindings orientated around sides rather than top and bottom.

F. Temporary Vegetation: Seed mixtures including rye, annual ryegrass, barley, Sudan grass, wheat, oats, Fescue, Lespedeza, millet, and/or Bermudagrass that provide quick protection shall be used to temporarily stabilize disturbed areas.

G. Temporary mulches shall consist of straw or hay, composted materials, wood chips or cellulose fiber, asphalt, and/or rolled erosion control products.

H. Erosion Control Blanket/Matting: Blanket and matting materials shall be non-toxic to vegetation. Netting shall be photodegradable and intertwined with mulch/fiber material. Mulch and fiber material shall consist of straw, excelsior (curled wood), coconut, or jute (woven root fiber).

PART 3 - EXECUTION

3.1 PROTECTION

A. Conduct construction so as to provide the site with maximum protection from erosion at all times.

B. Conduct excavation activities to provide erosion and sediment control as follows:
   1. Clearing and excavation shall not commence until such work is approved and permitted by local authorities having jurisdiction. Refer to the SWPPP and coordinate with authorities having jurisdiction for permitting requirements.
   2. Stockpile excavated material so as not to block any drainage area. Replace this excavated material in the trench immediately after repairs or installations have been completed and are approved by the Engineer or local authority.
   3. Retain natural vegetation whenever feasible.
   4. Stabilize exposed areas as quickly as possible by means of seeding and mulching. Use diversion ditches, or other methods, to prevent storm water from running over the exposed area until seeding is established as specified.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

5. Take particular care along streams and drainage ditches so that fallen trees, debris, and excavated material will not adversely affect the streamflow. Exercise care to minimize disturbance of streambanks. Wherever the streambanks are affected by construction, reduce the slope of the streambanks to provide a suitable condition for establishment of vegetative protection.
6. Retard the velocity of runoff water by use of barriers, traps and basins.
7. Trap the sediment contained in runoff water.
8. Take care during the hauling of materials, etc., to keep vehicles from creating a severe erosion problem.
9. Control dust by application of water or other means, as necessary.
10. Stabilize roadways and driveways as soon as feasible.

C. Regrade and stabilize surfaces eroded or otherwise damaged during any and all construction operations.

3.2 STABILIZED CONSTRUCTION ENTRANCE / EXIT

A. Length: As effective, but not less than 150 feet.

B. Thickness: Not less than eight (8) inches. A layer of medium grade filter fabric shall be placed on the subgrade before placement of stone.

C. Width: The full width of all points of ingress and egress, but not less than 20 feet.

D. Radii: Radii shall be appropriate for type of traffic, but not less than 20 feet.

E. Washing: When necessary, vehicles shall be cleaned of sediment prior to exiting the site onto public right-of-way. When washing is required, it shall be done in an area stabilized with crushed stone and draining into an approved sediment trap or basin. All sediment shall be prevented from entering any storm drain, ditch, or watercourse through use of approved methods.

F. Maintenance: The entrance shall be maintained in a condition, which prevents transport of sediment off of the site or onto public rights-of-way. This may require periodic top dressing with additional stone and maintenance of measures used to trap sediment. All sediment transported onto public rights-of-way shall be removed immediately.

3.3 SILT FENCING

A. Silt fencing shall be placed on proposed line, parallel to contours, and within an excavated trench of minimum 6 inch depth and width. Excavated soil shall be backfilled against the uphill side of the barrier. The bottom edge of silt fence must be entrenched and backfilled to be effective.

B. Silt fencing shall be purchased in continuous rolls and cut to length of the barrier. When joints are unavoidable, filter material shall be spliced together only at support posts and overlapped a minimum of 6 inches.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

C. Install the silt fence in accordance with the manufacturer's recommendations and the details shown on the Drawings.

3.4 STRAW BALE BARRIERS

A. Bales shall be installed in a trench excavated to the width of the bale, the length of the proposed barrier, and to a minimum depth of 4 inches. Excavated soil shall be backfilled against the uphill side of the barrier to a minimum depth of 4 inches.

B. Bales shall be placed in a single row, lengthwise on proposed line, with ends of adjacent bales tightly abutting one another, such that no gaps are evident. In swales and ditches the barrier shall extend up each side slope such that the bottoms of the end bales are higher in elevation than the top of the lowest middle bale.

C. Bales shall be anchored with at least two stakes or rebars through each bale and a minimum of 8 inches into the ground. Provide safety caps if rebar is used to anchor straw bales.

D. The gaps between bales shall be filled by wedging straw.

3.5 TEMPORARY VEGETATIVE COVER

A. Soil shall be tested to determined nutrient levels. If soil does not contain sufficient nutrient levels, work 12-12-12 analysis fertilizer 2 to 4 inches deep into soil at a rate of 400-600 pounds per acre.

B. Seed shall be certified by the local State Department of Transportation or Soil Conservation office.

C. To promote temporary vegetation establishment; provide lime, fertilizer (as determined by soil testing) and above-ground irrigation as necessary.

D. Provide mulch consisting of straw or hay, composted materials, wood chips or cellulose fiber, asphalt, or erosion control blanket to cover a minimum of 75% of the area receiving temporary vegetative cover.

E. Temporary vegetation shall be made non-viable, with herbicide or other means, prior to seeding and planting of permanent species.

3.6 EROSION CONTROL BLANKET/MATTING

A. Seed and fertilizer (if required) shall be applied before installation of a blanket or mat.

B. Follow manufacturer’s directions for orienting, overlapping, entrenching and securing blankets and mats. Generally orient blanket and mat rolls vertically along a slope, from top to bottom. Horizontal orientation is allowable only for slopes with steepness less than 2:1 and a height of less than twice the roll width.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

C. Always entrench the blanket or mat a minimum of 6 inches at any joint, any structure, and at the top and bottom of a slope.

3.7 ROCK CHECK DAMS

A. Provide rock check dams in locations shown on the plans. Maximum spacing shall be such that the toe of the upstream dam is at the same elevation as the top of the downstream dam.

B. The center of each check dam should be at least 9 inches lower than its outer edges. Height of the dam shall not exceed 2 feet at its centerline.

3.8 INLET PROTECTION

A. Excavation around the drop inlet (non-paved areas) shall be performed to accommodate the barrier type implemented (e.g. silt fence, straw bales, stone filled bags).

B. Placement of bales shall be lengthwise in a single row surrounding the drop inlet. Adjacent bales shall be pressed together and loose straw then wedged between them to prevent water from entering in between bales.

C. Staking shall be accomplished to securely anchor bales by driving at least two stakes or rebars through each bale and a minimum of 8 inches into the soil.

D. Backfill shall consist of excavated soil and shall be compacted against the straw barrier on the upstream side of the barrier.

3.9 DUST CONTROL

A. Dust generated during performance of the work shall be controlled by applying either water or calcium chloride.

B. Water or calcium chloride shall be provided in the amounts and locations in accordance with general local practice.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes administrative and procedural requirements for: selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; product substitutions; and comparable products.

B. Related Sections include the following:
   1. Division 01 Section "References" for applicable industry standards for products specified.
   2. Division 01 Section "Closeout Procedures" for submitting warranties for Contract closeout.
   3. Divisions 02 through 44 Sections for specific requirements for warranties on products and installations specified to be warranted.

1.3 DEFINITIONS

A. Products: Items purchased for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.
   1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation, shown or listed in manufacturer's published product literature that is current as of date of the Contract Documents.
   2. New Products: Items that have not previously been incorporated into another project or facility. Products salvaged or recycled from other projects are not considered new products.
   3. Comparable Product: Product that is demonstrated and approved through submittal process, or where indicated as a product substitution, to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.

B. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.

C. Basis-of-Design Product Specification: Where a specific manufacturer's product is named and accompanied by the words "basis of design," including make or model number or other designation, to establish the significant qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics for purposes of evaluating comparable products of other named manufacturers.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1.4 SUBMITTALS

A. Product List: Submit a list, in tabular form, showing specified products. Include generic names of products required. Include manufacturer's name and proprietary product names for each product.
   1. Coordinate product list with Contractor's Construction Schedule and the Submittals Schedule.
   2. Form: Tabulate information for each product under the following column headings:
      a. Specification Section number and title.
      b. Generic name used in the Contract Documents.
      c. Proprietary name, model number, and similar designations.
      d. Manufacturer's name and address.
      e. Supplier's name and address.
      f. Installer's name and address.
      g. Projected delivery date or time span of delivery period.
      h. Identification of items that require early submittal approval for scheduled delivery date.
   3. Completed List: Within 30 days after date of commencement of the Work, submit three copies of completed product list to the Engineer. Include a written explanation for omissions of data and for variations from Contract requirements.
   4. Engineer's Action: Engineer will respond in writing to Contractor within 30 days of receipt of completed product list. Engineer's response will include a list of unacceptable product selections and a brief explanation of reasons for this action. Engineer's response, or lack of response, does not constitute a waiver of requirement to comply with the Contract Documents.

B. Substitution Requests: Submit three copies of each request to the Engineer for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
   1. Substitution Request Form: Use form provided at end of Section. Other forms are not acceptable.
   2. Substitutions will not be considered when indicated on shop drawings or product data submittals.
   3. Substitutions will not be considered unless submitted through the General Contractor.
   4. Additional studies, investigations, submittals, redesign and/or analysis by the Engineer caused by requested substitution shall be paid by the Contractor at no expense to the Owner.
   5. Only one request for substitution for each product will be considered. When substitution is not acceptable to the Engineer, provide specified product.
   6. Engineer will determine the acceptability of all substitutions.
   7. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
      a. Statement indicating why specified material or product cannot be provided.
      b. Coordination information, including a list of changes or modifications needed to other parts of the Work that will be necessary to accommodate proposed substitution.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

c. Detailed comparison of significant qualities of proposed substitution with those of the Work specified. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
e. Samples, where applicable or requested.
f. List of similar installations for completed projects with project names and addresses and names and addresses of engineers and owners.
g. Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.
h. Research/evaluation reports evidencing compliance with building code in effect for Project, from a model code organization acceptable to authorities having jurisdiction.
i. Detailed comparison of Contractor's Construction Schedule using proposed substitution with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating lack of availability or delays in delivery.
j. Cost information, indicating the difference in cost between specified product(s) and proposed substitution.
k. Contractor's certification that proposed substitution complies with requirements in the Contract Documents and is appropriate for applications indicated.
l. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.

8. Engineer's Action: If necessary, Engineer will request additional information or documentation for evaluation within seven days of receipt of a request for substitution. Engineer will notify Contractor of acceptance or rejection of proposed substitution within 15 days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.
   a. Form of Acceptance: Change Order.
   b. Use product specified if Engineer cannot make a decision on use of a proposed substitution within time allocated.

C. Comparable Product Requests: Submit three copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
   1. Engineer Action: If necessary, Engineer will request additional information or documentation for evaluation within one week of receipt of a comparable product request. Engineer will notify Contractor of approval or rejection of proposed comparable product request within 15 days of receipt of request, or 7 days of receipt of additional information or documentation, whichever is later.
      a. Form of Approval: As specified in Division 01 Section "Submittal Procedures."
      b. Use product specified if Engineer cannot make a decision on use of a comparable product request within time allocated.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2. Engineer's Action: If necessary, Engineer will request additional information or documentation for evaluation upon receipt of a request for substitution. Engineer will notify all bidders of accepted substitution with issuance of an addendum.
   a. Use product specified if Engineer is unable to make a decision on use of a proposed substitution within time allocated.

D. Basis-of-Design Product Specification Submittal: Comply with requirements in Division 01 Section "Submittal Procedures." Show compliance with requirements.

1.5 QUALITY ASSURANCE

A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, product selected shall be compatible with products previously selected, even if previously selected products were also options.

1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft. Comply with manufacturer's written instructions.

B. Delivery and Handling:
   1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
   2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
   3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
   4. Inspect products on delivery to ensure compliance with the Contract Documents and to ensure that products are undamaged and properly protected.
   5. Store products to allow for inspection and measurement of quantity or counting of units.
   6. Store materials in a manner that will not endanger Project structure.
   7. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
   8. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
   9. Protect stored products from damage and liquids from freezing.
   10. Provide equipment and personnel to handle products by methods to prevent soiling or damage to products or packaging.
   11. Provide additional protection during handling as necessary to prevent scraping, marring, or otherwise damaging products or surrounding spaces.
   12. Handle products by using methods that will prevent bending or over stressing.
   13. Lift heavy components only at designated lifting points.

C. Storage: Provide a secure location and enclosure at Project site for storage of materials and equipment. Coordinate location with Owner.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1.7 PRODUCT WARRANTIES

A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.
   1. Manufacturer's Warranty: Preprinted written warranty published by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.
   2. Special Warranty: Written warranty required by or incorporated into the Contract Documents, either to extend time limit provided by manufacturer's warranty or to provide more rights for Owner.

B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution. Submit a draft for approval before final execution.
   1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
   2. Specified Form: When specified forms are included with the Specifications, prepare a written document using appropriate form properly executed.
   3. Refer to Divisions 02 through 44 Sections for specific content requirements and particular requirements for submitting special warranties.

C. Submittal Time: Comply with requirements in Division 01 Section "Closeout Procedures."

PART 2 - PRODUCTS

2.1 PRODUCT SELECTION PROCEDURES

A. General Product Requirements: Provide products that comply with the Contract Documents, that are undamaged, and unless otherwise indicated, that are new at time of installation.
   1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
   2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
   3. Owner reserves the right to limit selection to products with warranties not in conflict with requirements of the Contract Documents.
   4. Where products are accompanied by the term "as selected," Engineer will make selection.
   5. Where products are accompanied by the term "match sample," sample to be matched is Owner’s.
   6. Descriptive, performance, and reference standard requirements in the Specifications establish "salient characteristics" of products.
   7. Or Equal: Where products are specified by name and accompanied by the term "or equal" or "or approved equal" or "or approved," comply with provisions in Part 2 "Comparable Products" Article to obtain approval for use of an unnamed product.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Product Selection Procedures:
   1. Product: Where Specifications name a single product and manufacturer, provide the named product that complies with requirements..
   2. Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements.
   3. Products: Where Specifications include a list of names of both products and manufacturers, provide one of the products listed that complies with requirements.
   4. Manufacturers: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements.
   5. Visual Matching Specification: Where Specifications require matching an established Sample, select a product that complies with requirements and matches Engineer's sample. Engineer's decision will be final on whether a proposed product matches.
      a. If no product available within specified category matches and complies with other specified requirements, comply with provisions in Part 2 "Product Substitutions" Article for proposal of product.
   6. Visual Selection Specification: Where Specifications include the phrase "as selected from manufacturer's colors, patterns, textures" or a similar phrase, select a product that complies with other specified requirements.
      a. Standard Range: Where Specifications include the phrase "standard range of colors, patterns, textures" or similar phrase, Architect will select color, pattern, density, or texture from manufacturer's product line that does not include premium items.
      b. Full Range: Where Specifications include the phrase "full range of colors, patterns, textures" or similar phrase, Architect will select color, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

2.2 PRODUCT SUBSTITUTIONS

A. Timing: Engineer will consider requests for substitution if received within 10 days prior to Bid Opening date to allow time for evaluation and preparation of an Addendum, if required. Requests received after that time will not be considered.
   1. Delays caused by the tardiness of the Contractor in preparing and forwarding submittals will not be an acceptable basis for extension of the Contract completion date or for consideration of alternate products that do not meet the specified requirements of the Specifications.

B. Conditions: Engineer will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Engineer will return requests without action, except to record noncompliance with these requirements:
   1. Requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume. Owner's additional responsibilities may include compensation to Engineer for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.
   2. Requested substitution does not require extensive revisions to the Contract Documents.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3. Requested substitution is consistent with the Contract Documents and will produce indicated results.
4. Substitution request is fully documented and properly submitted.
5. Requested substitution will not adversely affect Contractor's Construction Schedule.
6. Requested substitution has received necessary approvals of authorities having jurisdiction.
7. Requested substitution is compatible with other portions of the Work.
8. Requested substitution has been coordinated with other portions of the Work.
9. Requested substitution provides specified warranty.
10. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

2.3 COMPARABLE PRODUCTS

A. Conditions: Engineer will consider Contractor's request for comparable product when the following conditions are satisfied. If the following conditions are not satisfied, Engineer will return requests without action, except to record noncompliance with these requirements:
   1. Evidence that the proposed product does not require extensive revisions to the Contract Documents that it is consistent with the Contract Documents and will produce the indicated results, and that it is compatible with other portions of the Work.
   2. Detailed comparison of significant qualities of proposed product with those named in the Specifications. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
   3. Evidence that proposed product provides specified warranty.
   4. List of similar installations for completed projects with project names and addresses and names and addresses of engineers and owners, if requested.
   5. Samples, if requested.

PART 3 - EXECUTION (Not Used)

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

Request for Substitution

This form must be completely filled in with all relevant data and submitted via General Contractor to Engineer. Modifications to this form are not permitted. Modified forms will be returned without review.

REFERENCE DATA

Engineer's Project No.: 26064.000 Date of Request: _____

Project Title: Contract 3 – Biosolids System Addition

SUBMITTED BY

Firm: _____

Address: _____

Name and Title of Person Signing: _____

Signature: _____ Date: _____

Telephone Number: _____

SUBSTITUTION REQUEST DATA

SUBSTITUTION REQUESTED IS FOR:
□ Named product (manufacturer/model)
□ Product type, material, finish or formulation.
□ Fabrication or installation methods.

Reason for request: _____

SPECIFIED ITEM IS INDICATED IN THE FOLLOWING DOCUMENTS:
Specification Section No. _____ Page and Paragraph: _____
Drawing (List all Drawings affected) No. _____

COST/BENEFIT ANALYSIS

Describe in detail alteration to other parts of the Project required by use of requested substitution:

Total net cost of any other required alterations, including overhead and profit: $ _____
Cost of Contractor's administration: $ _____
Total cost savings: $ _____
Total cost/benefit to Owner: $ _____

Benefits to Owner other than financial:

ADDITIONAL INFORMATION REQUIRED

COMPLETE THE REVERSE SIDE AND ATTACH THE FOLLOWING INFORMATION:

1. Manufacturer's technical data sheets on proposed products.
2. Manufacturer's standard form of warranty.
3. Letter on manufacturer's **letterhead** stating that manufacturer will warrant products as specified.

Request for Substitution

COMPARISON OF PRODUCTS

Fill in the following blanks as applicable to the product, material or method. As a guide, if an item is indicated in the Specification as a performance or materials requirement, corresponding information about the proposed substitution is required to facilitate evaluation of the proposed substitution. Requests lacking relevant information will be rejected. The burden of proof of the merit of the proposed substitution is upon the submitter:

SPECIFIED PRODUCT, MATERIAL OR METHOD	PROPOSED SUBSTITUTION
Description:	Description:
Product Name:	Product Name:
Type:	Type:
Model No:	Model No:
Fire rating (hours):	Fire rating (hours):
Thickness:	Thickness:
Composition:	Composition:
Availability (time):	Availability (time):
Country of manufacture:	Country of manufacture:
Substrate preparation required:	Substrate preparation required:
Length of warranty (years):	Length of warranty (years):
Length of finish warranty (years):	Length of finish warranty (years):
Extended warranty available?	Extended warranty available?
□ No □ Yes Number of Years	□ No □ Yes Number of Years
Sound transfer coefficient (STC):	Sound transfer coefficient (STC):
Resistance to chemicals, if specified (list):	Resistance to chemicals, if specified (list):
Other specified performance criteria (list):	Other specified performance criteria (list):

GENERAL CONTRACTOR'S REVIEW

I certify that I have reviewed the above documentation for the proposed Request for Substitution and warrant it to be substantially complete and accurate. I further certify that all other trades affected by the proposed substitution have been consulted and related material and labor costs have been addressed.

Name and Title of Person Signing: _____

Signature: _____ Date: _____

ENGINEER'S ACTION

- □ Accepted – Make submittals in accordance with product specification and Division 01 Section "Submittal Procedures".
- □ Accepted as Noted – Make submittals in accordance with product specification and Division 01 Section "Submittal Procedures".
- □ Rejected – Use specified product/materials.
- □ Received too late – use specified product/materials.

Signature _____ Date: _____

Remarks: _____

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This section includes the following:
   1. Owner furnished/Contractor installed equipment (OF/CI).
   2. Coordination and storage of all Owner furnished equipment.

B. Related Sections: The following sections contain requirements that relate to this section.
   1. Division 44 Section "Indirect Dryer System".

1.3 SUBMITTALS

A. Schedule: Contractor shall prepare and submit a schedule of dates for receiving rough-in data and taking delivery of OF/CI equipment.

1.4 QUALITY ASSURANCE

A. Installation of equipment shall be done by experienced workmen thoroughly trained in the necessary crafts to complete the work of this section.

B. Installation of each piece of equipment shall be in accordance with applicable mechanical and electrical codes.

1.5 RESPONSIBILITIES

A. Owner:
   1. Owner will arrange for and deliver Shop Drawings, Product Data, and Samples to Contractor. The Request for Proposal for the OF/CI equipment is reproduced in its entirety and provided at the end of these Specifications with the executed Purchase Order.
   2. Owner will arrange and pay for delivery of Owner-Furnished items according to the Request for Proposal.
   3. After delivery, Owner will inspect delivered items for damage. Contractor shall be present for and assist in Owner's inspection.
   4. If Owner-Furnished items are damaged, defective, or missing, Owner will arrange for replacement.
   5. Owner will arrange for manufacturer's field services and for delivery of manufacturer's warranties to Contractor.
   6. Owner will furnish Contractor the earliest possible delivery date for Owner-Furnished equipment. Contractor shall designate delivery date of Owner-Furnished item in Contractor's Construction Schedule. Delivery of equipment is set for April 2011.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Contractor:
   1. Contractor shall review Shop Drawings, Product Data, and Samples and return them to Owner and Engineer noting discrepancies or anticipated problems in use of product.
   2. Contractor is responsible for receiving, unloading, and handling Owner-Furnished items at project site.
   3. Contractor is responsible for protecting Owner-Furnished items from damage during storage and handling, including damage from exposure to the elements.
   4. If Owner-Furnished items are damaged as a result of Contractor's operations, Contractor shall repair or replace them.
   5. Contractor shall install and otherwise incorporate Owner-Furnished items into the Work.

1.6 COORDINATION

A. Extent of Owner furnished equipment is indicated in Equipment List at end of this Section.

B. The Request for Proposal can be found in its entirety at the end of these Specifications with the executed Purchase Order.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Rough-in and connection materials shall be as required by manufacturer's installation instructions.

2.2 ITEMS NOT INCLUDED BY THERMA-FLITE

A. The thermal fluid heater, provided by Therma-Flite, requires a 200-gallon catchment tank for drain of pressure relief valve, cold seal expansion tank, and vent. The catchment tank is not included as part of Therma-Flite's system and shall be provided by Contractor. All associated appurtenances to the catchment tank shall be the Contractor's responsibility and include: vent piping from the expansion tank, manual low-level test line, manual high-level test line, buffer drain from the expansion tank, pressure relief line, and any other related appurtenances.

B. All control valves for the dryer system are not being provided as part of Therma-Flite's system and shall be provided by the Contractor. Therma-Flite will be providing the control for the valves through Control Panel BSDCP-7030.

PART 3 - EXECUTION

3.1 COORDINATION

A. General Contractor shall be responsible for coordinating equipment installation with blocking in walls, mechanical and electrical rough-in and any special conditions indicated on submittal data received in accordance with his schedule of dates as agreed upon with the Owner.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Contractor shall arrange secure storage for equipment from the agreed upon delivery date until date of installation.

3.2 INSTALLATION

A. Installation shall be in accordance with manufacturer's requirements.

B. Set equipment square and level, securely anchored, with joints flush and tight, calked where required.

3.3 CLEANING, RESTORING FINISHES

A. After completion of installation, and completion of other major work in the area, remove protective coverings, if any, and clean equipment internally and externally. Restore exposed and semi-exposed finishes to remove abrasions and other damages; polish exposed metal surfaces and touch-up painted surfaces. Replace work which cannot be successfully restored.

3.4 TESTING, START-UP AND INSTRUCTIONS

A. Contractor shall inform Owner when start-up procedures can begin, shall furnish power as necessary and have electrical and mechanical contractor available to assist as required.

EQUIPMENT LIST

Equipment Number	Description	Furnished By / Installed By
1	One indirect dryer system as specified in Division 44 Section "Indirect Dryer System" including Therma-Flite's IC 10,000 dryer, cooling screw, thermal fluid heater, expansion tank, deaerator tank, buffer tank, condenser/ scrubber, and biological odor control system. Dryer to be installed as shown on the drawings in Dryer Building. Thermal Fluid Heater with appurtenances to be installed in adjacent room to Dryer Building. Items not included are the water control valves, catchment tank, and all associated appurtenances.	OF/CI

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes general procedural requirements governing execution of the Work including, but not limited to, the following:
   1. Construction layout.
   2. Field engineering and surveying.
   3. General installation of products.
   4. Coordination of Owner-installed products.
   5. Progress cleaning.
   6. Starting and adjusting.
   7. Protection of installed construction.
   8. Correction of the Work.

B. Related Sections include the following:
   1. Division 01 Section "Project Management and Coordination" for procedures for coordinating field engineering with other construction activities.
   2. Division 01 Section "Submittal Procedures" for submitting surveys.
   3. Division 01 Section "Cutting and Patching" for procedural requirements for cutting and patching necessary for the installation or performance of other components of the Work.
   4. Division 01 Section "Closeout Procedures" for submitting final property survey with Project Record Documents, recording of Owner-accepted deviations from indicated lines and levels, and final cleaning.

1.3 SUBMITTALS

A. Qualification Data: For Professional Engineer.

B. Certificates: Submit certificate signed by Professional Engineer certifying that location and elevation of improvements comply with requirements.

C. Landfill Receipts: Submit copy of receipts issued by a landfill facility, licensed to accept hazardous materials, for hazardous waste disposal.

D. Certified Surveys: Submit two copies signed by a Registered Land Surveyor.

E. Final Topographic Survey: Submit two copies showing the Work performed and record survey data.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1.4 QUALITY ASSURANCE

A. Land Surveyor Qualifications: A professional land surveyor who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing land-surveying services of the kind indicated.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Existing Utilities: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning sitework, investigate and verify the existence and location of underground utilities and other construction affecting the Work.
   1. Before construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, and water-service piping; and underground electrical services.
   2. Furnish location data for work related to Project that must be performed by public utilities serving Project site.

B. Existing Utility Interruptions: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
   1. Notify Owner not less than two days in advance of proposed utility interruptions.
   2. Do not proceed with utility interruptions without Owner's written permission.

C. Acceptance of Conditions: Examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.
   1. Written Report: Where a written report listing conditions detrimental to performance of the Work is required by other Sections, include the following:
      a. Description of the Work.
      b. List of detrimental conditions, including substrates.
      c. List of unacceptable installation tolerances.
      d. Recommended corrections.
   2. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Existing Utility Information: Furnish information to Owner that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

C. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.

D. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents, submit a request for information to Engineer. Include a detailed description of problem encountered, together with recommendations for changing the Contract Documents. **Submit requests on "Request for Information Form", provided in Division 01 Section "Project Management and Coordination".**

3.3 CONSTRUCTION LAYOUT

A. Verification: Before proceeding to lay out the Work, verify layout information shown on Drawings, in relation to the property survey and existing benchmarks. If discrepancies are discovered, notify Engineer promptly.

B. General: Engage a registered land surveyor to lay out the Work using accepted surveying practices.
1. Establish benchmarks and control points to set lines and levels at each story of construction and elsewhere as needed to locate each element of Project.
2. Establish dimensions within tolerances indicated. Do not scale Drawings to obtain required dimensions.
3. Inform installers of lines and levels to which they must comply.
4. Check the location, level and plumb, of every major element as the Work progresses.
5. Notify Engineer when deviations from required lines and levels exceed allowable tolerances.
6. Close site surveys with an error of closure equal to or less than the standard established by authorities having jurisdiction.

C. Site Improvements: Locate and lay out site improvements, including pavements, grading, fill and topsoil placement, utility slopes, and invert elevations.

D. Building Lines and Levels: Locate and lay out control lines and levels for structures, building foundations, column grids, and floor levels, including those required for mechanical and electrical work. Transfer survey markings and elevations for use with control lines and levels. Level foundations and piers from two or more locations.

E. Record Log: Maintain a log of layout control work. Record deviations from required lines and levels. Include beginning and ending dates and times of surveys, weather conditions, name and duty of each survey party member, and types of instruments and tapes used. Make the log available for reference by Engineer.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3.4 FIELD ENGINEERING

A. Identification: Owner will identify existing benchmarks, control points, and property corners.

B. Reference Points: Locate existing permanent benchmarks, control points, and similar reference points before beginning the Work. Preserve and protect permanent benchmarks and control points during construction operations.
   1. Do not change or relocate existing benchmarks or control points without prior written approval of Engineer. Report lost or destroyed permanent benchmarks or control points promptly. Report the need to relocate permanent benchmarks or control points to Engineer before proceeding.
   2. Replace lost or destroyed permanent benchmarks and control points promptly. Base replacements on the original survey control points.

C. Benchmarks: Establish and maintain a minimum of two permanent benchmarks on Project site, referenced to data established by survey control points. Comply with authorities having jurisdiction for type and size of benchmark.
   1. Record benchmark locations, with horizontal and vertical data, on Project Record Documents.
   2. Where the actual location or elevation of layout points cannot be marked, provide temporary reference points sufficient to locate the Work.
   3. Remove temporary reference points when no longer needed. Restore marked construction to its original condition.

D. Certified Survey: On completion of foundation walls, major site improvements, and other work requiring field-engineering services, prepare a certified survey showing dimensions, locations, angles, and elevations of construction and sitework.

E. Final Topographic Survey: Prepare a final topographic survey by a registered land surveyor showing significant features and finished grades for the Project.

3.5 INSTALLATION

A. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
   1. Make vertical work plumb and make horizontal work level.
   2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
   3. Conceal pipes, ducts, and wiring in finished areas, unless otherwise indicated.
   4. Maintain minimum headroom clearance of 8 feet (2.4 m) in spaces without a suspended ceiling.

B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.

C. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

D. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.

E. Tools and Equipment: Do not use tools or equipment that produce harmful noise levels.

F. Templates: Obtain and distribute to the parties involved templates for work specified to be factory prepared and field installed. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.

G. Anchors and Fasteners: Provide anchors and fasteners as required to anchor each component securely in place, accurately located and aligned with other portions of the Work.
   1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Engineer.
   2. Allow for building movement, including thermal expansion and contraction.
   3. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

H. Joints: Make joints of uniform width. Where joint locations in exposed work are not indicated, arrange joints for the best visual effect. Fit exposed connections together to form hairline joints.

I. Hazardous Materials: Use products, cleaners, and installation materials that are not considered hazardous.

3.6 OWNER-INSTALLED PRODUCTS

A. Site Access: Provide access to Project site for Owner's construction forces.

B. Coordination: Coordinate construction and operations of the Work with work performed by Owner's construction forces.
   1. Construction Schedule: Inform Owner of Contractor's preferred construction schedule for Owner's portion of the Work. Adjust construction schedule based on a mutually agreeable timetable. Notify Owner if changes to schedule are required due to differences in actual construction progress.
   2. Preinstallation Conferences: Include Owner's construction forces at preinstallation conferences covering portions of the Work that are to receive Owner's work. Attend preinstallation conferences conducted by Owner's construction forces if portions of the Work depend on Owner's construction.

3.7 PROGRESS CLEANING

A. General: Clean Project site and work areas daily, including common areas. Coordinate progress cleaning for joint-use areas where more than one installer has worked. Enforce requirements strictly. Dispose of materials lawfully.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
2. Do not hold materials more than 7 days during normal weather or 3 days if the temperature is expected to rise above 80 deg F(27 deg C).
3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.

B. Site: Maintain Project site free of waste materials and debris.

C. Work Areas: Clean areas where work is in progress to the level of cleanliness necessary for proper execution of the Work.
1. Remove liquid spills promptly.
2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.

D. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.

E. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.

F. Exposed Surfaces in Finished Areas: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.

G. Waste Disposal: Burying or burning waste materials on-site will not be permitted. Washing waste materials down sewers or into waterways will not be permitted.

H. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.

I. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.

J. Limiting Exposures: Supervise construction operations to assure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

3.8 STARTING AND ADJUSTING

A. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.

B. Adjust operating components for proper operation without binding. Adjust equipment for proper operation.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

C. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Manufacturer's Field Service: If a factory-authorized service representative is required to inspect field-assembled components and equipment installation, comply with qualification requirements in Division 01 Section "Quality Requirements."

3.9 PROTECTION OF INSTALLED CONSTRUCTION

A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.

B. Comply with manufacturer's written instructions for temperature and relative humidity.

3.10 CORRECTION OF THE WORK

A. Repair or remove and replace defective construction. Restore damaged substrates and finishes. Comply with requirements in Division 01 Section "Cutting and Patching."
   1. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment.

B. Restore permanent facilities used during construction to their specified condition.

C. Remove and replace damaged surfaces that are exposed to view if surfaces cannot be repaired without visible evidence of repair.

D. Repair components that do not operate properly. Remove and replace operating components that cannot be repaired.

E. Remove and replace chipped, scratched, and broken glass or reflective surfaces.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes procedural requirements for cutting and patching.

B. Related Sections include the following:
   1. Divisions 02 through 44 Sections for specific requirements and limitations applicable to cutting and patching individual parts of the Work.

1.3 DEFINITIONS

A. Cutting: Removal of in-place construction necessary to permit installation or performance of other Work.

B. Patching: Fitting and repair work required to restore surfaces to original conditions after installation of other Work.

1.4 SUBMITTALS

A. Cutting and Patching Proposal: Submit a proposal describing procedures at least 10 business days before the time cutting and patching will be performed, requesting approval to proceed. Include the following information:
   1. Extent: Describe cutting and patching, show how they will be performed, and indicate why they cannot be avoided.
   2. Changes to In-Place Construction: Describe anticipated results. Include changes to structural elements and operating components as well as changes in building's appearance and other significant visual elements.
   3. Products: List products to be used and firms or entities that will perform the Work.
   4. Dates: Indicate when cutting and patching will be performed.
   5. Utility Services and Mechanical/Electrical Systems : List services/systems that cutting and patching procedures will disturb or affect. List services/systems that will be relocated and those that will be temporarily out of service. Indicate how long services/systems will be disrupted.
   6. Structural Elements: Where cutting and patching involve adding reinforcement to structural elements, submit details and engineering calculations showing integration of reinforcement with original structure.
   7. Engineer's Approval: Obtain approval of cutting and patching proposal before cutting and patching. Approval does not waive right to later require removal and replacement of unsatisfactory work.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1.5 QUALITY ASSURANCE

A. Structural Elements: Do not cut and patch structural elements in a manner that could change their load-carrying capacity or load-deflection ratio.

B. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance or decreased operational life or safety.

C. Miscellaneous Elements: Do not cut and patch miscellaneous elements or related components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that result in increased maintenance or decreased operational life or safety.

D. Visual Requirements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch construction exposed on the exterior or in occupied spaces in a manner that would, in Engineer's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Comply with requirements specified in other Sections.

B. In-Place Materials: Use materials identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.
   1. If identical materials are unavailable or cannot be used, use materials that, when installed, will match the visual and functional performance of in-place materials.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces to be cut and patched and conditions under which cutting and patching are to be performed.
   1. Compatibility: Before patching, verify compatibility with and suitability of substrates, including compatibility with in-place finishes or primers.
   2. Proceed with installation only after unsafe or unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Temporary Support: Provide temporary support of Work to be cut.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.

C. Adjoining Areas: Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.

D. Existing Utility Services and Mechanical/Electrical Systems: Where existing services/systems are required to be removed, relocated, or abandoned, bypass such services/systems before cutting to prevent interruption to occupied areas.

3.3 PERFORMANCE

A. General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.
   1. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.

B. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.
   1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots as small as possible, neatly to size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
   2. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
   3. Concrete and Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
   4. Excavating and Backfilling: Comply with requirements in applicable Division 31 Sections where required by cutting and patching operations.
   5. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
   6. Proceed with patching after construction operations requiring cutting are complete.

C. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other Work. Patch with durable seams that are as invisible as possible. Provide materials and comply with installation requirements specified in other Sections.
   1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate integrity of installation.
   2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

a. Clean piping, conduit, and similar features before applying paint or other finishing materials.
b. Restore damaged pipe covering to its original condition.

3. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove in-place floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.
   a. Where patching occurs in a painted surface, apply primer and intermediate paint coats over the patch and apply final paint coat over entire unbroken surface containing the patch. Provide additional coats until patch blends with adjacent surfaces.
4. Ceilings: Patch, repair, or rehang in-place ceilings as necessary to provide an even-plane surface of uniform appearance.
   a. If in-place ceiling cannot be satisfactorily reinstalled, replace with like materials and construction.
   b. Replace damaged construction with like materials.
5. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition.

D. Cleaning: Clean areas and spaces where cutting and patching are performed. Completely remove paint, mortar, oils, putty, and similar materials.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Starting systems.
   2. Demonstration and instructions.
   3. Equipment and system commissioning.

B. Related Sections include the following:
   1. Division 01 Section “Mechanical and Electrical Coordination”.
   2. Division 01 Section “Submittal Procedures”.
   3. Division 01 Section “Quality Requirements”.
   4. Division 01 Section “Closeout Procedures”.
   5. Division 01 Section “Operation and Maintenance Data”.
   6. Division 01 Section "Demonstration and Training".

1.3 SUMMARY

A. Starting systems.

B. Demonstration and instructions.

C. Equipment and system commissioning.

1.4 STARTING SYSTEMS

A. Coordinate schedule for start-up of various equipment and systems in accordance with the requirements of Division 01 Section “Mechanical and Electrical Coordination”.

B. Notify Engineer 30 days prior to commissioning of each item.

C. In addition to the equipment operation maintenance data required in Division 01 Section “Operation and Maintenance Data,” two copies of the equipment Operation and Maintenance Manual (O&M Manual) shall accompany the Notice to the Engineer of the planned commissioning.

D. Certify in writing that each piece of equipment or system has been verified for proper lubrication, drive rotation, belt tension, control sequence, and that related equipment is operational as designed or other conditions which may cause damage.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

E. Certify in writing that tests, meter readings, and specified electrical characteristics comply with the requirements of the equipment or system manufacturer.

F. Certify in writing that wiring and support components for equipment, including instrumentation systems, are complete, tested, and comply with the requirements of the equipment or system manufacturer.

G. When specified in individual Specifications Sections, require manufacturer to provide authorized representative to be present at site to inspect and approve equipment or system installation prior to start-up, and to supervise the commissioning of the equipment or system.

H. Submit a written report to the Engineer in accordance with Division 01 Section "Quality Requirements" that equipment or system has been properly installed and is functioning correctly.

I. Mechanical and Electrical Coordinator shall certify in writing that the report is accurate and correct.

1.5 DEMONSTRATION AND INSTRUCTIONS

A. Demonstrate operation and maintenance of products and equipment to Owner's personnel prior to start-up of each item of equipment.

B. Demonstrate start-up, operation, control, adjustment, troubleshooting, servicing, maintenance, and shutdown of each item of equipment.

C. Arrange for qualified representative to conduct demonstrations and training.

D. Schedule demonstrations and training when the equipment to be explained is in place and ready for start-up.

E. Owner will designate a classroom located at or near the project site, if required.

F. Training shall include process equipment and system operations (minimum 2 days), mechanical equipment (minimum 1-1/2 days), and electrical and instrumentation systems (minimum 2 days). Longer periods of training may be required for some equipment items, as specified in the subsequent sections.

G. The Owner may, at his discretion, videotape the training sessions.

H. Prepare and insert additional data in O&M Manuals when need for additional data becomes apparent during instruction.

1.6 EQUIPMENT AND SYSTEM COMMISSIONING

A. Submit a detailed plan and schedule for commissioning thirty (30) days prior to anticipated start-up of each item. The start-up of each item shall be shown on the CPM Schedule.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Commissioning sequence shall be as follows:
   1. Provide O&M Manuals as required in Division 01 Section "Operation and Maintenance Data".
   2. Provide spare parts as required in individual equipment Sections.
   3. Staff and operate equipment which can be placed into continuous operation for a period of five successive 8-hour days. Owner will direct plant operations.
   4. During this period, Contractor shall pay for fuel, chemicals, maintenance, labor, and other related operating costs. Costs of electric power will be borne by the Owner.
   5. Perform work involved in starting operation of the equipment items. Arrange for factory-authorized representatives to start equipment when necessary or advisable.
   6. Start, stop, and control equipment.
   7. Open, close, and adjust valves.
   8. Make necessary observations of equipment.
   9. Keep written records on operations, personnel and time log of events.
   10. Maintain and clean equipment and areas.
   11. Do other work necessary for initial start-up and operation.

C. During this period, personnel of Owner and Engineer will be available for consultation.

D. After five continuous and satisfactory days (in the opinion of the Engineer) of operation, Owner will assume operation and costs for those facilities that were placed in operation. Repeat commissioning sequence if initial five day operation must be stopped due to equipment or system failure.

E. For those units which because of the nature of the process cannot be placed into operation until a later date, the same commissioning sequence shall be followed.

F. Special start-up procedures as may be required by other sections of the Specifications are in addition to the above requirements and shall be performed prior to initial start-up.

G. Owner will perform all sampling and laboratory analysis required for proper process control and monitoring. Based on these analyses, the Owner, through the Engineer, will instruct the Contractor as to required control parameters to set for the equipment and systems.

H. To the extent possible, based on control parameters imposed by the process control, the Contractor shall demonstrate that the equipment can be operated at the maximum and minimum extremes specified for the units.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:
   1. Inspection procedures.
   2. Project record documents.
   3. Warranties.
   4. Final cleaning.

B. Related Sections include the following:
   1. Division 01 Section "Execution" for progress cleaning of Project site.
   2. Division 01 Section "Project Record Documents" for submitting Record Drawings, Record Specifications, and Record Product Data.
   3. Division 01 Section "Operation and Maintenance Data" for operation and maintenance manual requirements.
   4. Division 01 Section "Demonstration and Training" for requirements for instructing Owner's personnel.
   5. Divisions 02 through 44 Sections for specific closeout and special cleaning requirements for the Work in those Sections.

1.3 SUBSTANTIAL COMPLETION

A. Preliminary Procedures: Before requesting inspection for determining date of Substantial Completion, complete the following. List items below that are incomplete in request.
   1. Prepare a list of items to be completed and corrected (punch list), the value of items on the list, and reasons why the Work is not complete.
   2. Advise Owner of pending insurance changeover requirements.
   3. Submit specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
   4. Obtain and submit releases permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
   5. Prepare and submit Project Record Documents, operation and maintenance manuals, Final Completion construction photographs and photographic negatives, damage or settlement surveys, property surveys, and similar final record information.
   6. Deliver tools, spare parts, extra materials, and similar items to location designated by Owner. Label with manufacturer's name and model number where applicable.
   7. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner's personnel of changeover in security provisions.
   8. Complete startup testing and commissioning of systems.
   9. Submit test/adjust/balance records.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

10. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
11. Advise Owner of changeover in heat and other utilities.
12. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.
13. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.
14. Complete final cleaning requirements, including touchup painting.

B. Inspection: Submit to the Engineer a written request for inspection for Substantial Completion. On receipt of request, Engineer will either proceed with inspection or notify Contractor of unfulfilled requirements. Engineer will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Engineer, that must be completed or corrected before certificate will be issued.
   1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.
   2. Results of completed inspection will form the basis of requirements for Final Completion.

1.4 FINAL COMPLETION

A. Preliminary Procedures: Before requesting final inspection for determining date of Final Completion, complete the following:
   1. Submit a final Application for Payment according to Division 01 Section "Payment Procedures."
   2. Submit certified copy of Engineer's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Engineer. The certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.
   3. Submit evidence of final, continuing insurance coverage complying with insurance requirements.
   4. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems. Submit demonstration and training videotapes.

B. Inspection: Submit to the Engineer a written request for final inspection for acceptance. On receipt of request, Engineer will either proceed with inspection or notify Contractor of unfulfilled requirements. Engineer will certify final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be certified.
   1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.
      a. Re-inspection fees: should status of completion of work require re-inspection by Engineer due to failure to comply with Contractor's claims on initial inspection, Owner will deduct the amount of Engineer compensation for re-inspection services from final payment to Contractor.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1.5 LIST OF INCOMPLETE ITEMS (PUNCH LIST)

A. Preparation: Submit to the Engineer three copies of list. Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction.
   1. Organize list of spaces in sequential order, starting with exterior areas first and proceeding from lowest floor to highest floor.
   2. Organize items applying to each space by major element, including categories for ceiling, individual walls, floors, equipment, and building systems.
   3. Include the following information at the top of each page:
      a. Project name.
      b. Date.
      c. Name of Engineer.
      d. Name of Contractor.
      e. Page number.

1.6 WARRANTIES

A. Submittal Time: Submit written warranties on request of Engineer for designated portions of the Work where commencement of warranties other than date of Substantial Completion is indicated.

B. Partial Occupancy: Submit properly executed warranties within 15 working days of completion of designated portions of the Work that are completed and occupied or used by Owner during construction period by separate agreement with Contractor.

C. Organize warranty documents into an orderly sequence based on the table of contents of the Project Manual.
   1. Bind warranties and bonds in heavy-duty, 3-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch (215-by-280-mm) paper.
   2. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of Installer.
   3. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of Contractor.

D. Provide additional copies of each warranty to include in operation and maintenance manuals.

1.7 SPARE PARTS

A. Contractor shall provide a master schedule of all spare parts comprised of the Spare Parts Schedules in each Operating & Maintenance (O&M) Manual and any additional spare parts not referenced by O&M manuals. Refer to Division 01 Section “Operation and Maintenance Data,” paragraph 2.5, F., for further details.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1.8 SPECIALTY TOOLS

A. Contractor shall provide a master schedule of tools supplied with equipment where those tools were required; i.e., hand-held programmers, remotes, torque wrenches, etc.

1.9 ACCEPTANCE AND TRAINING

A. Acceptance will not occur until after facility testing and training is completed. Start-up will not occur until all components have been started up by their respective manufacturer's representatives and successfully operated. Training will not occur until the facility and all of its components have been successfully started and operated as a whole for the test period defined in these documents. Training and start-up shall not be concurrent.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Cleaning Agents: Use cleaning materials and agents recommended by the manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

PART 3 - EXECUTION

3.1 FINAL CLEANING

A. General: Provide final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.

B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Comply with manufacturer's written instructions.
   1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a portion of Project:
      a. Clean Project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.
      b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
      c. Rake grounds that are neither planted nor paved to a smooth, even-textured surface.
      d. Remove tools, construction equipment, machinery, and surplus material from Project site.
      e. Remove snow and ice to provide safe access to building.
      f. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

g. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
h. Sweep concrete floors broom clean in unoccupied spaces.
i. Vacuum carpet and similar soft surfaces, removing debris and excess nap; shampoo if visible soil or stains remain.
j. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials. Polish mirrors and glass, taking care not to scratch surfaces.
k. Remove labels that are not permanent.
l. Touch up and otherwise repair and restore marred, exposed finishes and surfaces. Replace finishes and surfaces that cannot be satisfactorily repaired or restored or that already show evidence of repair or restoration.
    1) Do not paint over "UL" and similar labels, including mechanical and electrical nameplates.
m. Wipe surfaces of mechanical and electrical equipment and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
n. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
o. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
p. Clean ducts, blowers, and coils if units were operated without filters during construction.
q. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency. Replace burned-out bulbs, and those noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.
r. Leave Project clean and ready for occupancy.
s. Remove debris, rubbish, dirt, etc. from concealed spaces, chases, above ceilings, and from roof surfaces including roof drains, scuppers, gutters, leader heads, and downspouts.

C. Comply with safety standards for cleaning. Do not burn waste materials. Do not bury debris or excess materials on Owner's property. Do not discharge volatile, harmful, or dangerous materials into drainage systems. Remove waste materials from Project site and dispose of lawfully.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:
   1. Operation and maintenance documentation directory.
   2. Emergency manuals.
   3. Operation manuals for systems, subsystems, and equipment.
   4. Maintenance manuals for the care and maintenance of products, materials, finishes, systems, and equipment.

B. Related Sections include the following:
   1. Division 01 Section "Submittal Procedures" for submitting copies of submittals for operation and maintenance manuals.
   2. Division 01 Section "Closeout Procedures" for submitting operation and maintenance manuals.
   3. Division 01 Section "Project Record Documents" for preparing Record Drawings for operation and maintenance manuals.
   4. Division 01 Section "Demonstration and Training".
   5. Divisions 02 through 44 Sections for specific operation and maintenance manual requirements for the Work in those Sections.

1.3 DEFINITIONS

A. System: An organized collection of parts, equipment, or subsystems united by regular interaction.

B. Subsystem: A portion of a system with characteristics similar to a system.

1.4 SUBMITTALS

A. Initial Submittal: Submit three draft copies of each manual at least 15 days before requesting inspection for Substantial Completion. Include a complete operation and maintenance directory. Engineer will return one copy of draft and mark whether general scope and content of manual are acceptable.

B. Final Submittal: Submit two paper copies and two CDs of each manual in final form at least 15 days before final inspection. Engineer will return copy with comments within 15 days after final inspection. Files on CD copies should be in PDF format.
   1. Correct or modify each manual to comply with Engineer's comments. Submit three hard copies and three copies on CD/DVD of each corrected manual within 15 days of receipt of Engineer's comments.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1.5 COORDINATION

A. Where operation and maintenance documentation includes information on installations by more than one factory-authorized service representative, assemble and coordinate information furnished by representatives and prepare manuals.

PART 2 - PRODUCTS

2.1 OPERATION AND MAINTENANCE DOCUMENTATION DIRECTORY

A. Organization: Include a section in the directory for each of the following:
   1. List of documents.
   2. List of systems.
   3. List of equipment.
   4. Table of contents.

B. List of Systems and Subsystems: List systems alphabetically. Include references to operation and maintenance manuals that contain information about each system.

C. List of Equipment: List equipment for each system, organized alphabetically by system. For pieces of equipment not part of system, list alphabetically in separate list.

D. Tables of Contents: Include a table of contents for each emergency, operation, and maintenance manual.

E. Identification: In the documentation directory and in each operation and maintenance manual, identify each system, subsystem, and piece of equipment with same designation used in the Contract Documents.

2.2 MANUALS, GENERAL

A. Organization: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:
   1. Title page.
   2. Table of contents.
   3. Manual contents.

B. Title Page: Enclose title page in transparent plastic sleeve. Include the following information:
   1. Subject matter included in manual.
   2. Name and address of Project.
   3. Name and address of Owner.
   4. Date of submittal.
   5. Name, address, and telephone number of Contractor.
   6. Name and address of Engineer.
   7. Cross-reference to related systems in other operation and maintenance manuals.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

C. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.
   1. If operation or maintenance documentation requires more than one volume to accommodate data, include comprehensive table of contents for all volumes in each volume of the set.

D. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.
   1. Binders: Heavy-duty, 3-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, sized to hold 8-1/2-by-11-inch (215-by-280-mm) paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.
      a. If two or more binders are necessary to accommodate data of a system, organize data in each binder into groupings by subsystem and related components. Cross-reference other binders if necessary to provide essential information for proper operation or maintenance of equipment or system.
      b. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL," Project title or name, and subject matter of contents. Indicate volume number for multiple-volume sets.
   2. Dividers: Heavy-paper dividers with plastic-covered tabs for each section. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Project Manual.
   3. Protective Plastic Sleeves: Transparent plastic sleeves designed to enclose diagnostic software diskettes for computerized electronic equipment.
   4. Supplementary Text: Prepared on 8-1/2-by-11-inch (215-by-280-mm) white bond paper.
   5. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.
      a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
      b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.

2.3 EMERGENCY MANUALS

A. Content: Organize manual into a separate section for each of the following:
   1. Type of emergency.
   2. Emergency instructions.
   3. Emergency procedures.

B. Type of Emergency: Where applicable for each type of emergency indicated below, include instructions and procedures for each system, subsystem, piece of equipment, and component:
   1. Fire.
   2. Flood.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3. Gas leak.
4. Water leak.
5. Power failure.
6. Water outage.
7. System, subsystem, or equipment failure.
8. Chemical release or spill.

C. Emergency Instructions: Describe and explain warnings, trouble indications, error messages, and similar codes and signals. Include responsibilities of Owner's operating personnel for notification of Installer, supplier, and manufacturer to maintain warranties.

D. Emergency Procedures: Include the following, as applicable:
1. Instructions on stopping.
2. Shutdown instructions for each type of emergency.
3. Operating instructions for conditions outside normal operating limits.
4. Required sequences for electric or electronic systems.
5. Special operating instructions and procedures.

2.4 OPERATION MANUALS

A. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:
1. System, subsystem, and equipment descriptions.
2. Performance and design criteria if Contractor is delegated design responsibility.
3. Operating standards.
4. Operating procedures.
5. Operating logs.
6. Wiring diagrams.
7. Control diagrams.
8. Piped system diagrams.
9. Precautions against improper use.
10. License requirements including inspection and renewal dates.

B. Descriptions: Include the following:
1. Product name and model number.
2. Manufacturer's name.
3. Equipment identification with serial number of each component.
4. Equipment function.
5. Operating characteristics.
6. Limiting conditions.
7. Performance curves.
8. Engineering data and tests.
9. Complete nomenclature and number of replacement parts.

C. Operating Procedures: Include the following, as applicable:
1. Startup procedures.
2. Equipment or system break-in procedures.
3. Routine and normal operating instructions.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

4. Regulation and control procedures.
5. Instructions on stopping.
6. Normal shutdown instructions.
7. Seasonal and weekend operating instructions.
8. Required sequences for electric or electronic systems.
9. Special operating instructions and procedures.

D. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.

E. Piped Systems: Diagram piping as installed, and identify color-coding where required for identification.

2.5 PRODUCT MAINTENANCE MANUAL

A. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.

B. Source Information: List each product included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual.

C. Product Information: Include the following, as applicable:
1. Product name and model number.
2. Manufacturer's name.
3. Color, pattern, and texture.
4. Material and chemical composition.
5. Reordering information for specially manufactured products.
6. Product MSD sheet.

D. Maintenance Procedures: Include manufacturer's written recommendations and the following:
1. Inspection procedures.
2. Types of cleaning agents to be used and methods of cleaning.
3. List of cleaning agents and methods of cleaning detrimental to product.
4. Schedule for routine cleaning and maintenance.
5. Repair instructions.

E. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.

F. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
1. Include procedures to follow and required notifications for warranty claims.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2.6 SYSTEMS AND EQUIPMENT MAINTENANCE MANUAL

A. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranty and bond information, as described below.

B. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual.

C. Manufacturers' Maintenance Documentation: Manufacturers' maintenance documentation including the following information for each component part or piece of equipment:
   1. Standard printed maintenance instructions and bulletins.
   2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
   3. Identification and nomenclature of parts and components.
   4. List of items recommended to be stocked as spare parts.

D. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:
   1. Test and inspection instructions.
   2. Troubleshooting guide.
   3. Precautions against improper maintenance.
   4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
   5. Aligning, adjusting, and checking instructions.
   6. Demonstration and training videotape, if available.

E. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.
   1. Scheduled Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semiannual, and annual frequencies.
   2. Maintenance and Service Record: Include manufacturers' forms for recording maintenance.
   3. In addition to the above, the Contractor shall prepare a MAINTENANCE SUMMARY FORM. This form will be compiled from information received from each manufacturer or supplier for routine and preventative maintenance required for their equipment in order to meet their warranty requirements. Tasks shall be listed for daily, weekly, monthly, etc. Each MAINTENANCE SUMMARY FORM shall be bound into the front of the dividers of the respective section of the Operating and Maintenance Manual. Contractor shall use the form at the end of the Section for all equipment. Use of different forms for different equipment will not be accepted. Substitute formats must be approved prior to preparation.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

F. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.

G. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.

H. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
   1. Include procedures to follow and required notifications for warranty claims.

2.7 THROUGH-PENETRATION FIRESTOP SYSTEMS MANUAL

A. Content: Detail and description of each through-penetration Firestop system installed.

PART 3 - EXECUTION

3.1 MANUAL PREPARATION

A. Operation and Maintenance Documentation Directory: Prepare a separate manual that provides an organized reference to emergency, operation, and maintenance manuals.

B. Emergency Manual: Assemble a complete set of emergency information indicating procedures for use by emergency personnel and by Owner's operating personnel for types of emergencies indicated.

C. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.

D. Operation and Maintenance Manuals: Assemble a complete set of operation and maintenance data indicating operation and maintenance of each system, subsystem, and piece of equipment not part of a system.
   1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
   2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.
   3. Warranties and Bonds:
      a. Except for items put into use with Owner's permission, leave date of beginning of warranty until Date of Substantial Completion is determined.
      b. Verify that documents are in proper form, contain full information, and are notarized.
      c. Co-execute documents when required.

E. Manufacturers' Data: Where manuals contain manufacturers' standard printed data, include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.

F. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in Record Drawings to ensure correct illustration of completed installation.
   1. Do not use original Project Record Documents as part of operation and maintenance manuals.
   2. Comply with requirements of newly prepared Record Drawings in Division 01 Section "Project Record Documents."

G. Comply with Division 01 Section "Closeout Procedures" for schedule for submitting operation and maintenance documentation.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

MAINTENANCE SUMMARY FORM

Project: _____ Contract No: _____

1. Equipment Item: _____

2. Manufacturer or Supplier: _____

3. Equipment/Tag Number: _____

4. Weight of individual components (over 100 pounds): _____

5. Nameplate data: _____

6. Manufacturer's Local Representative: _____

Address: _____ Phone: _____

7. Maintenance Requirements:

Maintenance Operation Comments	Frequency	Lubricant (if applicable)
List briefly each maintenance operation required. (Reference to manufacturer's catalog or sales literature is not acceptable.)	List required frequency (Daily, weekly, monthly, etc.)	List brand and identification number

8. Recommended Spare Parts for Owner's Inventory:

Part No.	Description	Quantity	Re-Ordering Procedure

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes administrative and procedural requirements for Project Record Documents, including the following:
   1. Record Drawings.

B. Related Sections include the following:
   1. Division 01 Section "Closeout Procedures" for general closeout procedures.
   2. Division 01 Section "Operation and Maintenance Data" for operation and maintenance manual requirements.
   3. Divisions 02 through 44 Sections for specific requirements for Project Record Documents of the Work in those Sections.

1.3 SUBMITTALS

A. Record Drawings: Comply with the following:
   1. Number of Copies: Submit to the Engineer one set of marked-up Record Prints.

1.4 MISCELLANEOUS RECORD SUBMITTALS

A. Refer to Specification Sections for miscellaneous record-keeping requirements and submittals in connection with various construction activities. Immediately before Substantial Completion, complete miscellaneous records and place in good order, properly identified and bound or filed, ready for use and reference. Miscellaneous records include, but are not limited to, the following:
   1. Field records on excavations and foundations.
   2. Field records on underground construction and similar work.
   3. Surveys showing locations and elevations of underground lines.
   4. Invert elevations of drainage piping.
   5. Surveys establishing building lines and levels.
   6. Authorized measurements using unit prices or allowances.
   7. Records of plant treatment.
   8. Ambient and substrate condition tests.
   9. Certifications received in lieu of labels on bulk products.
   10. Batch mixing and bulk delivery records.
   11. Testing and qualification of installation firms.
   12. Documented qualification of installation firms.
   13. Load and performance testing.
   14. Inspections and certifications by governing authorities.
   15. Leakage and water-penetration tests.
   16. Fire-resistance and flame-spread results.
   17. Final inspection and correction procedures.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 2 - PRODUCTS

2.1 RECORD DRAWINGS

A. Record Prints: Maintain one set of blue- or black-line white prints of the Contract Drawings and Shop Drawings.
   1. Preparation: Mark Record Prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to prepare the marked-up Record Prints.
      a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
      b. Accurately record information in an understandable drawing technique.
      c. Record data as soon as possible after obtaining it. Record and check the markup before enclosing concealed installations.
   2. Content: Types of items requiring marking include, but are not limited to, the following:
      a. Dimensional changes to Drawings.
      b. Revisions to details shown on Drawings.
      c. Depth of foundations.
      d. Locations and depths of underground utilities.
      e. Revisions to routing of piping and conduits.
      f. Revisions to electrical circuitry.
      g. Actual equipment locations.
      h. Duct size and routing.
      i. Locations of concealed internal utilities.
      j. Changes made by Change Order or Construction Change Directive.
      k. Changes made following Engineer's written orders.
      l. Details not on the original Contract Drawings.
      m. Field records for variable and concealed conditions.
      n. Record information on the Work that is shown only schematically.

B. Format: Identify and date each Record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.
   1. Record Prints: Organize Record Prints into manageable sets. Include identification on cover sheets.
   2. Identification: As follows:
      a. Project name.
      b. Date.
      c. Designation "PROJECT RECORD DRAWINGS."
      d. Name of Engineer.
      e. Name of Contractor.

2.2 MISCELLANEOUS RECORD SUBMITTALS

A. Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 3 - EXECUTION

3.1 RECORDING AND MAINTENANCE

A. Recording: Maintain one copy of each submittal during the construction period for Project Record Document purposes. Post changes and modifications to Project Record Documents as they occur; do not wait until the end of Project.

B. Maintenance of Record Documents: Store Record Documents in the field office apart from the Contract Documents used for construction. Do not use Project Record Documents for construction purposes. Maintain Record Documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to Project Record Documents for Engineer's reference during normal working hours.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes administrative and procedural requirements for instructing Owner's personnel, including the following:
   1. Demonstration of operation of systems, subsystems, and equipment.
   2. Training in operation and maintenance of systems, subsystems, and equipment.
   3. Demonstration and training videotapes.

B. Related Sections include the following:
   1. Division 01 Section "Project Management and Coordination" for requirements for preinstruction conferences.
   2. Divisions 02 through 44 Sections for specific requirements for demonstration and training for products in those Sections.

1.3 SUBMITTALS

A. Instruction Program: Submit two copies of outline of instructional program for demonstration and training, including a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Include learning objective and outline for each training module.
   1. At completion of training, submit one complete training manual for Owner's use.

B. Qualification Data: Each instructor must have a minimum of five (5) years experience in operation and maintenance of subject equipment.

C. Attendance Record: For each training module, submit list of participants and length of instruction time.

D. Evaluations: For each participant and for each training module, submit results and documentation of performance-based test.

E. Demonstration and Training Videotapes or DVDs: The Owner will, at their option, video record the training sessions.

1.4 QUALITY ASSURANCE

A. Instructor Qualifications: A factory-authorized service representative, complying with requirements in Division 01 Section "Quality Requirements," experienced in operation and maintenance procedures and training.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Preinstruction Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination." Review methods and procedures related to demonstration and training including, but not limited to, the following:
   1. Inspect and discuss locations and other facilities required for instruction.
   2. Review and finalize instruction schedule and verify availability of educational materials, instructors' personnel, audiovisual equipment, and facilities needed to avoid delays.
   3. Review required content of instruction.
   4. For instruction that must occur outside, review weather and forecasted weather conditions and procedures to follow if conditions are unfavorable.

1.5 COORDINATION

A. Coordinate instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations.

B. Coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.

C. Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data has been reviewed and approved by Engineer.

PART 2 - PRODUCTS

2.1 INSTRUCTION PROGRAM

A. Program Structure: Develop an instruction program that includes individual training modules for each system and equipment not part of a system, as required by individual Specification Sections.

B. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following:
   1. Basis of System Design, Operational Requirements, and Criteria: Include the following:
      a. System, subsystem, and equipment descriptions.
      b. Performance and design criteria if Contractor is delegated design responsibility.
      c. Operating standards.
      d. Regulatory requirements.
      e. Equipment function.
      f. Operating characteristics.
      g. Limiting conditions.
      h. Performance curves.
   2. Documentation: Review the following items in detail:
      a. Emergency manuals.
      b. Operations manuals.
      c. Maintenance manuals.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

d. Project Record Documents.
e. Identification systems.
f. Warranties and bonds.
g. Maintenance service agreements and similar continuing commitments.

3. Emergencies: Include the following, as applicable:
   a. Instructions on meaning of warnings, trouble indications, and error messages.
   b. Instructions on stopping.
   c. Shutdown instructions for each type of emergency.
   d. Operating instructions for conditions outside of normal operating limits.
   e. Sequences for electric or electronic systems.
   f. Special operating instructions and procedures.
4. Operations: Include the following, as applicable:
   a. Startup procedures.
   b. Equipment or system break-in procedures.
   c. Routine and normal operating instructions.
   d. Regulation and control procedures.
   e. Control sequences.
   f. Safety procedures.
   g. Instructions on stopping.
   h. Normal shutdown instructions.
   i. Operating procedures for emergencies.
   j. Operating procedures for system, subsystem, or equipment failure.
   k. Seasonal and weekend operating instructions.
   l. Required sequences for electric or electronic systems.
   m. Special operating instructions and procedures.
5. Adjustments: Include the following:
   a. Alignments.
   b. Checking adjustments.
   c. Noise and vibration adjustments.
   d. Economy and efficiency adjustments.
6. Troubleshooting: Include the following:
   a. Diagnostic instructions.
   b. Test and inspection procedures.
7. Maintenance: Include the following:
   a. Inspection procedures.
   b. Types of cleaning agents to be used and methods of cleaning.
   c. List of cleaning agents and methods of cleaning detrimental to product.
   d. Procedures for routine cleaning
   e. Procedures for preventive maintenance.
   f. Procedures for routine maintenance.
   g. Instruction on use of special tools.
8. Repairs: Include the following:
   a. Diagnosis instructions.
   b. Repair instructions.
   c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
   d. Instructions for identifying parts and components.
   e. Review of spare parts needed for operation and maintenance.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 3 - EXECUTION

3.1 PREPARATION

A. Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a combined training manual.

B. Set up instructional equipment at instruction location.

3.2 INSTRUCTION

A. Engage qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.
   1. Engineer will furnish an instructor to describe basis of system design, operational requirements, criteria, and regulatory requirements.
   2. Owner will furnish an instructor to describe Owner's operational philosophy.
   3. Owner will furnish Contractor with names and positions of participants.

B. Scheduling: Provide instruction at mutually agreed on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.
   1. Schedule training with Owner, through Engineer, with at least seven days' advance notice.

C. Evaluation: At conclusion of each training module, assess and document each participant's mastery of module by use of a written performance-based test.

D. Cleanup: Collect used and leftover educational materials and give to Owner. Remove instructional equipment. Restore systems and equipment to condition existing before initial training use.

3.3 DEMONSTRATION AND TRAINING VIDEO RECORDING

A. General: The Owner will, at their option, record the demonstrations and training sessions.

B. Manufacturers' Disclaimer: The Manufacturer's Representative/Instructor shall be permitted to insert a disclaimer that the demonstration and training is a spontaneous presentation and that the operating and maintenance personnel should follow the written procedures in the O&M Manuals if conflicts are encountered.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

1.3 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and install accessories for concrete joints as shown on the Drawings and as specified herein.

1.4 RELATED WORK

A. Division 03 Section "Concrete Formwork".

B. Division 03 Section "Concrete Reinforcement".

C. Division 03 Section "Cast-In-Place Concrete".

D. Division 03 Section "Grout".

E. Sealants and Caulking are included in Division 7.

1.5 SUBMITTALS

A. Submit to the Engineer, in accordance with Division 01 Section "Submittal Procedures", shop drawings and product data. Submittals shall include at least the following:
   1. Standard Waterstops: Product data including catalogue cut, technical data, storage requirements, splicing methods and conformity to ASTM standards.
   2. Special Waterstops: Product data including catalogue cut, technical data, location of use, storage requirements, splicing methods, installation instructions and conformity to ASTM standards.
   3. Pre-molded joint fillers: Product data including catalogue cut, technical data, storage requirements, installation requirements, location of use and conformity to ASTM standards.
   4. Bond breaker: Product data including catalogue cut, technical data, storage requirements, installation requirements, location of use and conformity to ASTM standards.
   5. Expansion joint dowels: Product data on the complete assembly including dowels, coatings, lubricants, spacers, sleeves, expansion caps, installation requirements and conformity to ASTM standards.
   6. Compressible joint filler: Product data including catalogue cut, technical data, storage requirements, installation requirements, location of use and conformity to ASTM standards.

7. Bonding agents: Product data including catalogue cut, technical data, storage requirements, product life, application requirements and conformity to ASTM standards.

B. Certifications
   1. Certification that all materials used within the joint system is compatible with each other.

1.6 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM)
   1. ASTM A675 - Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality, Mechanical Properties.
   2. ASTM C881 - Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
   3. ASTM C1059 - Standard Specification for Latex Agents for Bonding Fresh to Hardened Concrete.
   4. ASTM D1751 - Standard Specification for Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction. (Non-extruding and Resilient Bituminous Types).
   5. ASTM D1752 - Standard Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.

B. U.S. Army Corps of Engineers (CRD): CRD C572 - Specification for Polyvinylchloride Waterstops.

C. Federal Specifications: FS SS-S-210A - Sealing Compound for Expansion Joints.

D. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

PART 2 - PRODUCTS

2.1 GENERAL

A. The use of manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.

B. All materials used together in a given joint (bond breakers, backer rods, joint fillers, sealants, etc) shall be compatible with one another. Coordinate selection of suppliers and products to ensure compatibility. Under no circumstances shall asphaltic bond breakers or joint fillers be used in joints receiving sealant.

C. All chemical sealant type waterstops shall be products specifically manufactured for the purpose for which they will be used and the products shall have been successfully used on similar structures for more than five years.

2.2 MATERIALS

A. Special Waterstops
   1. PVC Waterstop - The waterstop shall be made by extruding elastomeric plastic compound with virgin polyvinylchloride as the basic resins. The compound shall contain no reprocessed materials. Minimum tensile strength of waterstop shall be 1750 psi. The waterstop shall conform to CRD-C572. Waterstops shall be 757 by Greenstreak Plastic Products, St. Louis, MO or approved equal.
   2. Preformed adhesive waterstops - The waterstop shall be a rope type preformed plastic waterstop meeting the requirements of Federal Specification SS-S-210A. The rope shall have a cross-section of approximately one square inch unless otherwise specified or shown on the Drawings. The waterstop shall be Synko-Flex waterstop as manufactured by Synko-Flex Products of Houston, TX or approved equal. Primer for the material shall be as recommended by the waterstop manufacturer.

B. Pre-molded Joint Filler
   1. Pre-molded joint filler - structures. Self-expanding cork, pre-molded joint filler shall conform to ASTM D1752, Type III. The thickness shall be 3/4-in unless shown otherwise on the Drawings.
   2. Pre-molded joint filler - sidewalk and roadway concrete pavements or where fiber joint filler is specifically noted on the Drawings. The joint filler shall be asphalt-impregnated fiber board conforming to ASTM D1751. Thickness shall be 3/4-in unless otherwise shown on the Drawings.

C. Bond Breaker
   1. Bond breaker tape shall be an adhesive-backed glazed butyl or polyethylene tape which will satisfactorily adhere to the pre-molded joint filler or concrete surface as required. The tape shall be the same width as the joint.
   2. Except where tape is specifically called for on the drawings, bond breaker for concrete shall be either bond breaker tape or a non-staining type bond prevention coating such as Williams Tilt-up Compound by Williams Distributors Inc.; Silcoseal 77, by SCA Construction Supply Division, Superior Concrete Accessories or approved equal.

D. Expansion Joint Dowels:
   1. Dowels shall be smooth steel conforming to ASTM A675, Grade 70. Dowels must be straight and clean, free of loose flaky rust and loose scale. Dowels may be sheared to length provided deformation from true shape caused by shearing does not exceed 0.04-in on the diameter of the dowel and extends no more than 0.04-in from the end. Bars shall be coated with a bond breaker on the expansion end of the dowel. Expansion caps shall be provided on the expansion end. Caps shall allow for at least 1-1/2-in of expansion.

E. Bonding Agent:
   1. Epoxy bonding agent shall be a two-component, solvent-free, moisture insensitive, epoxy resin material conforming to ASTM C881, Type II. The bonding agent shall be Sikadur 32 Hi-Mod by Sika Corporation of Lyndhurst, N.J.; Concresive Liquid (LPL) by Master Builders of Cleveland, OH or approved equal.

F. Compressible Joint Filler:
   1. The joint filler shall be a non-extruded watertight strip material use to fill expansion joints between structures. The material shall be capable of being compressed at least 40 percent for 70 hours at 68 degrees F and subsequently recovering at least 20 percent of its original thickness in the first 1/2 hour after unloading. Compressible Joint filler shall be Evasote 380 E.S.P, by E-Poxy Industries, Inc., Ravena, NY or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Special Waterstops:
   1. Install special waterstops at joints where specifically noted on the Drawings. Waterstops shall be continuous around all corners and intersections so that a continuous seal is provided.
   2. Each piece of the waterstop shall be of maximum practicable length to provide a minimum number of connections or splices. Connections and splices shall conform to the manufacturer's recommendations and as specified herein.
   3. Waterstops shall be terminated 3-in below the exposed top of walls.
   4. PVC base seal waterstops shall be spliced as specified for PVC standard waterstops. Base seals for expansion joints shall set on concrete sleeper beams, not less than 24-in wide, and the beam covered with two layers of sheet material such as vapor barrier material. The seal shall not be fastened by nails but firmly held in position by the bulkhead form. Base seals at non-expansion joints may be set on vapor barrier material that extends at least two feet on each side of the joint.
   5. All flat and vertical tees, elbows, and crosses shall be factory fabricated by the manufacturer, leaving only straight butt joint splices for the field.

B. Construction Joints:
   1. Make construction joints only at locations shown on the Drawings or as approved by the Engineer. Any additional or relocation of construction joints proposed by the Contractor, must be submitted to the Engineer for written approval.
   2. Additional or relocated joints should be located where they least impair strength of the member. In general, locate joints within the middle third of spans of slabs, beams and girders. However, if a beam intersects a girder at the joint, offset the joint a distance equal to twice the width of the member being connected. Locate joints in walls and columns at the underside of floors, slabs, beams or girders and at tops of footings or floor slabs. Do not locate joints between beams, girders, column capitals, or drop panels and the slabs above them. Do not locate joints between brackets or haunches and walls or columns supporting them.
   3. All joints shall be perpendicular to main reinforcement. Continue reinforcing steel through the joint as indicated on the Drawings. When joints in beams are allowed, provide a shear key and inclined dowels as approved by the Engineer.
   4. Provide sealant grooves for joint sealant where indicated on the Drawings.
   5. At all construction joints and at concrete joints designated on the Drawings to be "roughened", uniformly roughen the surface of the concrete to a full amplitude (distance between high and low points or side to side) of approximately 1/4-in to expose a fresh face. Thoroughly clean joint surfaces of loose or weakened materials by water blasting

or sandblasting and prepare for bonding. At least 2 hours before and again shortly before the new concrete is deposited, the joints and adjacent concrete surfaces to at least 12-in past the joint shall be saturated with water. After glistening water disappears, the joints shall be given a thorough coating of neat cement slurry mixed to the consistency of very heavy paste. The surfaces shall receive a coating at least 1/8-in thick, well scrubbed-in by means of stiff bristle brushes whenever possible. Horizontal wall joints with no access to the earlier concrete placement surface shall have the roughened surface thoroughly coated with a neat cement slurry of pouring consistency. New concrete shall be deposited before the neat cement dries.

6. In lieu of the above method for bonding plastic concrete to hardened concrete, the following optional method may be used. Concrete must be allowed to set a minimum of 28 days. Use an epoxy bonding agent applied to roughened and cleaned surfaces of set concrete in strict accordance with manufacturer's recommendations.
7. Provide waterstops in all wall and slab construction joints in liquid containment structures and at other locations shown on the Drawings.
8. Keyways shall not be used in construction joints unless specifically shown on the Drawings or approved by the Engineer.

C. Expansion Joints:
   1. Do not extend through expansion joints, reinforcement or other embedded metal items that are continuously bonded to concrete on each side of joint.
   2. Position pre-molded joint filler material accurately. Secure the joint filler against displacement during concrete placement and compaction. Place joint filler over the face of the joint, allowing for sealant grooves as detailed on the Drawings. Tape all joint filler splices to prevent intrusion of mortar. Seal expansion joints as shown on the Drawings.
   3. Expansion joints shall be 3/4-in in width unless otherwise noted on the Drawings.
   4. Where indicated on Drawings, install smooth dowels at right angles to expansion joints. Align dowels accurately with finished surface. Rigidly hold in place and support during concrete placement. Unless otherwise shown on the Drawings, apply oil or grease to one end of all dowels through expansion joints. Provide plastic expansion caps on the lubricated ends of expansion dowels.
   5. Provide center bulb type waterstops in all wall and slab expansion joints in liquid containment structures and at other locations shown on the Drawings.

D. Control Joints:
   1. Provide sealant grooves, sealants and waterstops at control joints in slabs on grade or walls as detailed. Provide waterstops at all wall and slab control joints in water containment structures and at other locations shown on the Drawings.
   2. Control joints may be sawed if specifically approved by the Engineer. If control joint grooves are sawed, properly time the saw cutting with the time of the concrete set. Start cutting as soon as concrete has hardened sufficiently to prevent aggregates from being dislodged by the saw. Complete cutting before shrinkage stresses have developed sufficiently to induce cracking. No reinforcing shall be cut during saw cutting.
   3. Extend every other bar of reinforcing steel through control joints or as indicated on the Drawings. Where specifically noted on the Drawings, coat the concrete surface with a bond breaker prior to placing new concrete against it. Avoid coating reinforcement or waterstops with bond breaker at these locations.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals, Design, install and remove formwork for cast-in-place concrete as shown on the Drawings and as specified herein.

B. Secure to forms as required or set for embedment. Provide all miscellaneous metal items, sleeves, reglets, anchor bolts, inserts and other items furnished under other Sections and required to be cast into concrete.

1.3 RELATED WORK

A. Division 03 Section "Concrete Reinforcement".

B. Division 03 Section "Concrete Joints and Joint Accessories".

C. Division 03 Section "Cast-in-Place Concrete".

D. Division 03 Section "Grout".

1.4 SUBMITTALS

A. Submit to the Engineer, in accordance with Division 01 Section "Submittal Procedures", shop drawings and product data showing materials of construction and details of installation for:
   1. Form release agent
   2. Form ties

B. Samples: Demonstrate to the Engineer on a designated area of the concrete substructure exterior surface that the form release agent will not adversely affect concrete surfaces to be painted, coated or otherwise finished and will not affect the forming materials.

C. Certificates: Certify form release agent is suitable for use in contact with potable water after 30 days (non-toxic and free of taste and odor).

1.5 REFERENCE STANDARDS

A. American Concrete Institute (ACI)
   1. ACI 301 - Standard Specification for Structural Concrete
   2. ACI 318 - Building Code Requirements for Reinforced Concrete
   3. ACI 347 - Formwork for Concrete

B. American Plywood Association (APA): Material grades and designations as specified

C. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.6 QUALITY ASSURANCE

A. The form liner manufacturer's representative shall be on-site during the initial installation of the form liner to instruct the Contractor on the proper methods of application and use of the liner. He/She shall be available to answer any questions on the liner that the Engineer may have.

1.7 SYSTEM DESCRIPTION

A. General: Architectural Concrete is wall, slab, beam or column concrete which will have surfaces exposed to view in the finished work.

B. Structural design responsibility: All forms and shoring shall be designed at the Contractor's expense by a professional engineer registered in the State of Tennessee. Formwork shall be designed and erected in accordance with the requirements of ACI 301 and ACI 318 and as recommended in ACI 347 and shall comply with all applicable regulations and codes. The design shall consider any special requirements due to the use of plasticized and/or retarded set concrete.

PART 2 - PRODUCTS

2.1 GENERAL

A. The usage of a manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configurations desired.

2.2 MATERIALS

A. Forms for cast-in-place concrete shall be made of wood, metal, or other approved material. Wood forms for the project shall be new and unused. Construct wood forms of sound lumber or plywood of suitable dimensions and free from knotholes and loose knots. Where used for exposed surfaces, dress and match boards. Sand plywood smooth and fit adjacent panels with tight joints. Metal forms may be used when approved by the Engineer and shall be of an appropriate type for the class of work involved. All forms shall be designed and constructed to provide a flat, uniform concrete surface requiring minimal finishing or repairs.

B. Wall Forms
   1. Forms for all exposed exterior and interior concrete walls shall be new and unused "Plyform" exterior grade plywood panels manufactured in compliance with the APA and bearing the trademark of that group, or equal acceptable to the Engineer. Provide B grade or better veneer on all faces to be placed against concrete during forming. The class of material and grades of interior plies shall be of sufficient strength and stiffness to provide a flat, uniform concrete surface requiring minimal finishing and grinding.

2. All joints or gaps in forms shall be taped, gasketed, plugged, and/or caulked with an approved material so that the joint will remain watertight and will withstand placing pressures without bulging outward or creating surface patterns.
3. Forms for circular structures shall conform to the circular shape of the structure. Straight panels may be substituted for circular panels if the straight panels do not exceed 2-ft in width nor deflect more than 3-1/2 degrees per joint, nor conflict with specific notes on the Drawings.

C. Column Forms
1. Rectangular columns shall be formed as specified for wall forms. All corners shall have a 3/4-in chamfer unless otherwise noted on the Drawings.

D. Rustications shall be at the location and shall conform to the details shown on the Drawings. Moldings for chamfers and rustications shall be milled and planed smooth. Rustications and corner strips shall be of a nonabsorbent material, compatible with the form surface and fully sealed on all sides to prohibit the loss of paste or water between the two surfaces.

E. Form Release Agent
Coat all forming surfaces in contact with concrete using an effective, non-staining, non-residual, water based, bond-breaking form coating unless otherwise noted. Form release agents used in potable water containment structures shall be suitable for use in contact with potable water and shall be non-toxic and free of taste or odor.

F. Concrete surfaces which are to be painted shall be formed with hard plastic finished plywood or a similar material which does not require a form release agent unless the Contractor can substantiate to the satisfaction of the Engineer that the form release agent will not remain on the formed surface after it is stripped.

G. Form Ties
1. Form ties encased in concrete other than those specified in the following paragraphs shall be designed so that, after removal of the projecting part, no metal shall remain within 1-1/2-in of the face of the concrete. The part of the tie to be removed shall be at least 1/2-in diameter or be provided with a wood or metal cone at least 1/2-in diameter and 1-1/2-in long. Form ties in concrete exposed to view shall be the cone-washer type.
2. Form ties for exposed exterior and interior walls shall be as specified in the preceding paragraph except that the cones shall be of approved wood or plastic.
3. Flat bar ties for panel forms shall have plastic or rubber inserts having a minimum depth of 1-1/2-in and sufficient dimensions to permit proper patching of the tie hole.
4. Ties for liquid containment structures shall have an integral waterstop that is tightly welded to the tie.
5. Common wire shall not be used for form ties.
6. Alternate form ties consisting of tapered through-bolts at least 1-in in diameter at smallest end or through-bolts that utilize a removable tapered sleeve of the same minimum size may be used at the Contractor's option. Obtain Engineer's acceptance of system and spacing of ties prior to ordering or purchase of forming. Clean, fill and seal form tie hole with non-shrink cement grout. The Contractor shall be responsible for water tightness of the form ties and any repairs needed.

H. Bond breakers for precast and tilt-up construction when cast against concrete shall be a non-staining, non-residual type, which will provide a positive bond prevention. Bond breakers shall be Williams Distributors, Inc., Seattle, WA - Williams Tilt-Up Compound; SCA Construction Supply Division, Superior Concrete Accessories, Franklin Park, IL - Silcoseal 77 or approved equal.

PART 3 - EXECUTION

3.1 GENERAL

A. Forms shall be used for all cast-in-place concrete including sides of footings. Forms shall be constructed and placed so that the resulting concrete will be of the shape, lines, dimensions and appearance indicated on the Drawings.

B. Forms for walls shall have removable panels at the bottom for cleaning, inspection and joint surface preparation. Forms for walls of considerable height shall have closable intermediate inspection ports. Tremies and hoppers for placing concrete shall be used to allow concrete inspection, prevent segregation and prevent the accumulation of hardened concrete on the forms above the fresh concrete.

C. Molding, bevels, or other types of chamfer strips shall be placed to produce block-outs, rustications, or chamfers as shown on the Drawings or as specified herein. Chamfer strips shall be provided at horizontal and vertical projecting corners to produce a 3/4-in chamfer. Rectangular or trapezoidal moldings shall be placed in locations requiring sealants where specified or shown on the Drawings. Sizes of moldings shall conform to the sealants manufacturer's recommendations.

D. Forms shall be sufficiently rigid to withstand construction loads and vibration and to prevent displacement or sagging between supports. Construct forms so that the concrete will not be damaged by their removal. The Contractor shall be entirely responsible for the adequacy of the forming system.

E. Before form material is re-used, all surfaces to be in contact with concrete shall be thoroughly cleaned, all damaged places repaired, all projecting nails withdrawn and all protrusions smoothed. Reuse of wooden forms for other than rough finish will be permitted only if a "like new" condition of the form is maintained.

3.2 FORM TOLERANCES

A. Forms shall be surfaced, designed and constructed in accordance with the recommendations of ACI 347 and shall meet the following additional requirements for the specified finishes.

B. Formed Surface Exposed to View: Edges of all form panels in contact with concrete shall be flush within 1/32-in and forms for plane surfaces shall be such that the concrete will be plane within 1/16-in in 4-ft. Forms shall be tight to prevent the passage of mortar, water and grout. The maximum deviation of the finish wall surface at any point shall not exceed 1/4-in from the intended surface as shown on the Drawings. Form panels shall be arranged symmetrically and in an orderly manner to minimize the number of seams.

C. Formed surfaces not exposed to view or buried shall meet requirements of Class "C" Surface in ACI 347.

D. Formed rough surfaces including mass concrete, pipe encasement, electrical duct encasement and other similar installations shall have no minimum requirements for surface smoothness and surface deflections. The overall dimensions of the concrete shall be plus or minus 1-in.

E. Formed concrete Surfaces to Receive Paint: Surface deflections shall be limited to 1/32-in at any point and the variation in wall deflection shall not exceed 1/16-in per 4-ft. The maximum deviation of the finish wall surface at any point shall not exceed 1/4-in from the intended surface as shown on the Drawings.

3.3 FORM PREPARATION

A. Wood forms in contact with the concrete shall be coated with an effective release agent prior to form installation.

B. Steel forms shall be thoroughly cleaned and mill scale and other ferrous deposits shall be sandblasted or otherwise removed from the contact surface for all forms, except those utilized for surfaces receiving a rough finish. All forms shall have the contact surfaces coated with a release agent.

3.4 REMOVAL OF FORMS

A. The Contractor shall be responsible for all damage resulting from removal of forms. Forms and shoring for structural slabs or beams shall remain in place in accordance with ACI 301 and ACI 347. Form removal shall conform to the requirements specified in Section 03 300.

3.5 INSPECTION

A. The Engineer shall be notified when the forms are complete and ready for inspection at least 6 hours prior to the proposed concrete placement.

B. Failure of the forms to comply with the requirements specified herein or to produce concrete complying with requirements of this Section shall be grounds for rejection of that portion of the concrete work. Rejected work shall be repaired or replaced as directed by the Engineer at no additional cost to the Owner. Such repair or replacement shall be subject to the requirements of this Section and approval of the Engineer.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and install all concrete reinforcement complete as shown on the Drawings and as specified herein.

B. Furnish only all deformed steel reinforcement required to be entirely built into concrete masonry unit construction.

1.3 RELATED WORK

A. Division 03 Section "Concrete Formwork".

B. Division 03 Section "Concrete Joint and Joint Accessories".

C. Division 03 Section "Cast-in-Place Concrete".

D. Division 03 Section "Grout".

E. Reinforced Unit Masonry is included in Division 04.

1.4 SUBMITTALS

A. Submit to the Engineer, in accordance with Division 01 Section "Submittal Procedures", shop drawings and product data showing materials of construction and details of installation for:
   1. Reinforcing steel. Placement drawings shall conform to the recommendations of ACI 315. All reinforcement in a concrete placement shall be included on a single placement drawing or cross referenced to the pertinent main placement drawing. The main drawing shall include the additional reinforcement (around openings, at corners, etc) shown on the standard detail sheets. Bars to have special coatings and/or to be of special steel or special yield strength are to be clearly identified.
   2. Bar bending details. The bars shall be referenced to the same identification marks shown on the placement drawings. Bars to have special coatings and/or to be of special steel or special yield strength shall be clearly identified.

B. Submit Test Reports, in accordance with Division 01 Section "Demonstration and Training", of each of the following items.
   1. Certified copy of mill test on each steel proposed for use showing the physical properties of the steel and the chemical analysis.
   2. Welder's certification. The certification shall be in accordance with AWS D1.4 when welding of reinforcement required.

1.5 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM)
   1. ASTM A82 - Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
   2. ASTM A184 - Standard Specification for Fabricated Deformed Steel Bar Mats for Concrete Reinforcement.
   3. ASTM A185 - Standard Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
   4. ASTM A496 - Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement
   5. ASTM A497 - Standard Specification for Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement
   6. ASTM A615 - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
   7. ASTM A616 - Standard Specification for Rail-Steel Deformed and Plain Bars for Concrete Reinforcement
   8. ASTM A617 - Standard Specification for Axle-Steel Deformed and Plain Bars for Concrete Reinforcement
   9. ASTM A706 - Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
   10. ASTM A767 - Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement
   11. ASTM A775 - Standard Specification for Epoxy-Coated Reinforcing Steel Bars.
   12. ASTM A884 - Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Fabric for Reinforcement.
   13. ASTM A934 - Standard Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars.

B. American Concrete Institute (ACI)
   1. ACI 301 - Standard Specification for Structural Concrete
   2. ACI 315 - Details and Detailing of Concrete Reinforcement.
   3. ACI 318 - Building Code Requirements for Structural Concrete
   4. ACI SP-66 - ACI Detailing Manual

C. Concrete Reinforcing Steel Institute (CRSI)
   1. Manual of Standard Practice

D. American Welding Society (AWS)
   1. AWS D1.4 - Structural Welding Code Reinforcing Steel

E. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.6 DELIVERY, HANDLING AND STORAGE

A. Reinforcing steel shall be substantially free from mill scale, rust, dirt, grease, or other foreign matter.

B. Reinforcing steel shall be shipped and stored with bars of the same size and shape fastened in bundles with durable tags, marked in a legible manner with waterproof markings showing the same "mark" designations as those shown on the submitted Placing Drawings.

C. Reinforcing steel shall be stored off the ground, protected from moisture and kept free from dirt, oil, or other injurious contaminants.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Materials shall be new, of domestic manufacture and shall comply with the following material specifications.

B. Deformed Concrete Reinforcing Bars: ASTM A615, Grade 60 deformed bars.

C. Concrete Reinforcing Bars required on the Drawings to be welded: ASTM A706.

D. Welded Steel Wire Fabric: ASTM A185. Provide in flat sheets.

E. Welded Deformed Steel Wire Fabric: ASTM A497.

F. Welded Plain Bar Mats: ASTM A704 and ASTM A615 Grade 60 plain bars.

G. Fabricated Deformed Steel Bar Mats: ASTM A184 and ASTM A615 Grade 60 deformed bars.

H. The following alternate materials are allowed:
   1. ASTM A615 Grade 60 may be used for ASTM A706 provided the following requirements are satisfied:
      a. The actual yield strength of the reinforcing steel based on mill tests shall not exceed the specified yield strength by more than 18,000 psi. Retests shall not exceed this value by more than an additional 3000 psi.
      b. The ratio of the actual ultimate tensile strength to the actual tensile yield strength of the reinforcement shall not be less than 1.25.
      c. The carbon equivalency (CE) of bars shall be 0.55 or less.

I. Reinforcing Steel Accessories
   1. Plastic Protected Bar Supports: CRSI Bar Support Specifications, Class 1 - Maximum Protection.
   2. Stainless Steel Protected Bar Supports: CRSI Bar Support Specifications, Class 2 - Moderate Protection.
   3. Precast Concrete Block Bar Supports: CRSI Bar Support Specifications, Precast Blocks. Blocks shall have equal or greater strength than the surrounding concrete.

J. Tie Wire
   1. Tie Wires for Reinforcement shall be 16-gauge or heavier, black annealed wire.

K. Mechanical reinforcing steel butt splices shall be positive connecting taper threaded type employing a hexagonal coupler such as Lenton rebar splices as manufactured by Erico Products Inc., Solon, OH or approved equal. They shall meet all ACI 318 Building Code requirements. Bar ends must be taper threaded with coupler manufacturer's bar threader to ensure proper taper and thread engagement. Bar couplers shall be torqued to manufacturer's recommended value.
   1. Unless otherwise noted on the Drawings, mechanical tension splices shall be designed to produce a splice strength in tension or compression of not less than 125 percent of the ASTM specified minimum yield strength of the rebar.
   2. Compression type mechanical splices shall provide concentric bearing from one bar to the other bar and shall be capable of developing the ultimate strength of the rebar in compression.

2.2 FABRICATION

A. Fabrication of reinforcement shall be in compliance with the CRSI Manual of Standard Practice.

B. Bars shall be cold bent. Bars shall not be straightened or re-bent.

C. Bars shall be bent around a revolving collar having a diameter of not less than that recommended by the ACI 318.

D. Bar ends that are to be butt spliced, placed through limited diameter holes in metal, or threaded, shall have the applicable end(s) saw-cut. Such ends shall terminate in flat surfaces within 1-1/2 degrees of a right angle to the axis of the bar.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Surface condition, bending, spacing and tolerances of placement of reinforcement shall comply with the CRSI Manual of Standard Practice. The Contractor shall be solely responsible for providing an adequate number of bars and maintaining the spacing and clearances shown on the Drawings.

B. Except as otherwise indicated on the Drawings, the minimum concrete cover of reinforcement shall be as follows:
   1. Concrete cast against and permanently exposed to earth: 3-inch
   2. Concrete exposed to soil, water, sewage, sludge and/or weather: 2-inch (Including bottom cover of slabs over water or sewage)
   3. Concrete not exposed to soil, water, sewage, sludge and/or weather:
      a. Slabs (top and bottom cover), walls, joists, shells and folded plate members - 1-inch.
      b. Beams and columns (principal reinforcement, ties, spirals and stirrups) - 1-1/2-inch.

C. Reinforcement which will be exposed for a considerable length of time after being placed shall be coated with a heavy coat of neat cement slurry.

D. No reinforcing steel bars shall be welded either during fabrication or erection unless specifically shown on the Drawings or specified herein, or unless prior written approval has been obtained from the Engineer. All bars that have been welded, including tack welds, without such approval shall be immediately removed from the work. When welding of reinforcement is approved or called for, it shall comply with AWS D1.4.

E. Reinforcing steel interfering with the location of other reinforcing steel, conduits or embedded items may be moved within the specified tolerances or one bar diameter, whichever is greater. Greater displacement of bars to avoid interference shall only be made with the approval of the Engineer. Do not cut reinforcement to install inserts, conduits, mechanical openings or other items without prior approval of the Engineer.

F. Securely support and tie reinforcing steel to prevent movement during concrete placement. Secure dowels in place before placing concrete.

G. Reinforcing steel bars shall not be field bent except where shown on the Drawings or specifically authorized in writing by the Engineer. If authorized, bars shall be cold- bent around the standard diameter spool specified in the CRSI. Do not heat bars. Closely inspect the reinforcing steel for breaks. If the reinforcing steel is damaged, replace, Cadweld or otherwise repair as directed by the Engineer. Do not bend reinforcement after it is embedded in concrete unless specifically shown otherwise on the Drawings.

3.2 REINFORCEMENT AROUND OPENINGS

A. Unless specific additional reinforcement around openings is shown on the Drawings, provide additional reinforcing steel on each side of the opening equivalent to one half of the cross-sectional area of the reinforcing steel interrupted by an opening. The bars shall have sufficient length to develop bond at each end beyond the opening or penetration.

3.3 SPLICING OF REINFORCEMENT

A. Splices designated as compression splices on the Drawings, unless otherwise noted, shall be 30 bar diameters, but not less than 12-in. The lap splice length for column vertical bars shall be based on the bar size in the column above.

B. Tension lap splices shall be provided at all laps in compliance with ACI 318. Splices in adjacent bars shall be staggered. Class A splices may be used when 50 percent or less of the bars are spliced within the required lap length. Class B splices shall be used at all other locations.

C. Except as otherwise indicated on the Drawings, splices in circumferential reinforcement in circular walls shall be Class B tension splices and shall be staggered. Adjacent bars shall not be spliced within the required lap length.

D. Splicing of reinforcing steel in concrete elements noted to be "tension members" on the Drawings shall be avoided whenever possible. However, if required for constructability, splices in the reinforcement subject to direct tension shall be welded to develop, in tension, at least 125 percent of the specified yield strength of the bar. Splices in adjacent bars shall be offset the distance of a Class B splice.

E. Install wire fabric in as long lengths as practicable. Splices in welded wire fabric shall be lapped in accordance with the requirements of ACI-318 but not less than 12-inch. The spliced fabrics shall be tied together with wire ties spaced not more than 24-inch on center and laced with wire of the same diameter as the welded wire fabric. Do not position laps midway between supporting beams, or directly over beams of continuous structures. Offset splices in adjacent widths to prevent continuous splices.

F. Mechanical reinforcing steel splicers shall be used only where shown on the Drawings. Splices in adjacent bars shall be offset by at least 30 bar diameters. Mechanical reinforcing splices are only to be used for special splice and dowel conditions approved by the Engineer.

3.4 ACCESSORIES

A. Determine, provide and install accessories such as chairs, chair bars and the like in sufficient quantities and strength to adequately support the reinforcement and prevent its displacement during the erection of the reinforcement and the placement of concrete.

B. Use precast concrete blocks where the reinforcing steel is to be supported over soil.

C. Stainless steel bar supports or steel chairs with stainless steel tips shall be used where the chairs are set on forms for a concrete surface that will be exposed to weather, high humidity, or liquid (including bottom of slabs over liquid containing areas). Use of galvanized or plastic tipped metal chairs is permissible in all other locations unless otherwise noted on the Drawings or specified herein.

D. Alternate methods of supporting top steel in slabs, such as steel channels supported on the bottom steel or vertical reinforcing steel fastened to the bottom and top mats, may be used if approved by the Engineer.

3.5 INSPECTION

A. In no case shall any reinforcing steel be covered with concrete until the installation of the reinforcement, including the size, spacing and position of the reinforcement has been observed by the Engineer and the Engineer's release to proceed with the concreting has been obtained. The Engineer shall be given ample prior notice of the readiness of placed reinforcement for observation. The forms shall be kept open until the Engineer has finished his/her observations of the reinforcing steel.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section specifies cast-in place concrete, concrete materials, mix design, placement procedures, and finishes for cast-in-place concrete footings, foundation walls, slabs-on-grade, shearwalls, suspended slabs, building frame members, equipment pads, thrust blocks, light pole bases, and building foundation members.

B. Related Sections include the following:
   1. Division 03 Sections "Concrete Joints and Joint Accessories", "Concrete Formwork", "Concrete Reinforcement" and "Grout".
   2. Division 31 Section "Site Excavation, Backfilling, and Compaction" for drainage fill under slabs-on-grade.
   3. Division 32 Section "Concrete Paving" for concrete pavement and walks.

1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume, subject to compliance with requirements.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Design Mixes: For each concrete mixture, submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
   1. Indicate amounts of mix water to be withheld for later addition at Project site.
   2. Submit concrete mix designs, product data and material reports for each class of concrete fifteen (15) days before starting any concrete work. If historical tests are utilized, average breaks and standard deviation calculations shall be included with the submittal, in accordance with ACI-318. The submittal shall include, but not be limited to, the following:
      a. Source and type of each cement/cementitious material proposed for the Project, including mill test reports and manufacturer's Certification of Compliance.
      b. Source, types, and individual gradings for each aggregate.
      c. The fineness modulus, saturated surface-dry specific gravity, and absorption of all aggregates.
      d. Dry-rodded unit weight for coarse aggregates.
      e. The vendor and type of all admixtures.
      f. Source of mixing water.
      g. Chloride ion content for each ingredient.

C. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement, prepared according to ACI 315, "Details and Detailing of Concrete Reinforcement." Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports of concrete reinforcement. Include special reinforcement required for openings through concrete structures. Show schematic elevations at reinforced cast-in-place concrete walls.

D. Slab Placement Schedule: For supported concrete slabs, indicating sequence of pours, construction joint locations, and pour strips.

E. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated, based on comprehensive testing of current materials:
   1. Aggregates. Include service record data indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity.
   2. Admixtures.
   3. Curing materials.
   4. Bonding agents.
   5. Adhesives.
   6. Vapor retarders.
   7. Repair materials.

F. Manufacturer's letter of certification that curing compound will not affect the adhesion of subsequent materials to be applied to concrete.

G. Field quality control test and inspection reports.

H. Quality control program of the concrete supplier.

I. Proposed repair methods, materials, and modifications to the work.

1.5 QUALITY ASSURANCE

A. All concrete work shall conform to the "Building Code Requirements for Reinforced Concrete", ACI 318.

B. Field Reference Manual: Contractor shall have a copy of the latest edition of "ACI Manual SP-15" available in field office.

C. Perform concrete reinforcement work in accordance with CRSI "Manual of Standard Practice," and ACI 315.

D. Installer Qualifications: An experienced installer who has completed concrete Work similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

E. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products complying with ASTM C 94 requirements for production facilities and equipment.

F. Testing Agency Qualifications: Testing agency used for mix design, mix design verification, materials certification, field quality control shall be an independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 to conduct the testing indicated, as documented according to ASTM E 548.
   1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
   2. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician – Grade I. Testing agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician – Grade II.

G. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, each aggregate from one source, and each admixture from the same manufacturer.

H. Welding: Qualify procedures and personnel according to AWS D1.4, "Structural Welding Code--Reinforcing Steel."

I. ACI Publications: Comply with the following, unless more stringent provisions are indicated:
   1. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
   2. ACI 301, "Specification for Structural Concrete."
   3. ACI 302, "Guide for Concrete Floor and Slab Construction."
   4. ACI 304, "Recommended Practice for Measuring and Placing Concrete."
   5. ACI 305, "Hot Weather Concreting."
   6. ACI 306, "Cold Weather Concreting."
   7. ACI 315, "Details and Detailing for Concrete Reinforcement."
   8. ACI 347, "Recommended Practice for Concrete Formwork."
   9. ACI Manual SP-15.
   10. ACI 546, "Concrete Repair Guide."

J. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."
   1. Before submitting design mixes, review concrete mix design and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
      a. Contractor's superintendent.
      b. Independent testing agency responsible for concrete design mixes.
      c. Ready-mix concrete producer.
      d. Concrete subcontractor.
      e. Independent testing agency responsible for testing concrete samples.
      f. Architect.
      g. Special inspector.
   2. Review special inspection and testing requirements and procedures, concrete finishes and finishing, cold- and hot-weather concreting procedures, curing procedures, construction, contraction, and isolation joints, joint filler strips, semi-rigid joint fillers, forms and form removal limitations, shoring and reshoring procedures, vapor-retarder installation, steel reinforcement installation, concrete repair procedures and concrete protection.

K. Submit, in accordance with Chapter 17 of the International Building Code, the following:
   1. Acknowledgement of awareness of the special requirements contained in the quality assurance plan for seismic resistance.
   2. Acknowledgement that control will be exercised to obtain conformance with the Construction Documents approved by the building official.
   3. Procedures for exercising control within the Contractor's organization, the method and frequency of reporting, and the distribution of the reports.
   4. Identification and qualifications of the person(s) exercising such control and their position(s) in the organization.

PART 2 - PRODUCTS

2.1 CONCRETE MATERIALS

A. Cementitious Materials: Use the following cementitious materials, of the same type, brand, and source, throughout the Project:
   1. Portland Cement: ASTM C150, Type I with no more than eight percent of tricalcium aluminate. Supplement with the following:
      a. Fly Ash: ASTM C 618, Class F.

B. Normal-Weight Aggregate: ASTM C 33, Class 3S coarse aggregate or better, graded. Provide aggregates from a single source with documented service record data of at least 10 years' satisfactory service in similar applications and service conditions using similar aggregates and cementitious materials. Aggregate gap grading shall not be used on slabs-on-grade.
   1. Local aggregates not complying with ASTM C 33 but which have been shown by special tests or actual service to produce concrete of adequate strength and durability may be used when acceptable to the Architect.
   2. Coarse aggregate shall consist of gravel, crushed stone, crushed gravel, or a combination of each. Fine aggregate shall consist of natural sand, manufactured sand, or a combination of each.
   3. The nominal maximum size of coarse aggregate shall not be larger than one-fifth (1/5) the narrowest dimension between formwork, one third (1/3) the slab depth, three-fourths (3/4) the clear spacing between individual reinforcing, or the clear cover of the reinforcing.
   4. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Water: Potable and complying with ASTM C 94.

2.2 ADMIXTURES

A. Air-Entraining Admixture: ASTM C 260.

B. Chemical Admixtures: Provide admixtures certified by manufacturer to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material and to be compatible with other admixtures and cementitious materials so that the admixtures will not contribute water-soluble ions exceeding those limits permitted in hardened concrete. Do not use admixtures containing calcium chloride.

1. Chemical admixtures shall not be used without the approval of the concrete mix designer.
2. Water-Reducing Admixture: ASTM C 494, Type A.
3. Retarding Admixture: ASTM C 494, Type B.
4. Water-Reducing and Retarding Admixture: ASTM C 494, Type D.
5. High-Range, Water-Reducing Admixture: ASTM C 494, Type F.
6. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494, Type G.
7. Plasticizing and Retarding Admixture: ASTM C 1017, Type II.

2.3 VAPOR RETARDERS

A. Plastic Vapor Retarder: Polyethylene sheet, ASTM D 4397, not less than 10 mils (0.25 mm) thick. Include manufacturer's recommended adhesive or pressure-sensitive joint tape.

2.4 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) when dry.

C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

D. Water: Potable.

E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.

2.5 RELATED MATERIALS

A. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

B. Epoxy-Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements, and as follows:

2.6 REPAIR MATERIALS

A. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.
   1. Cement Binder: ASTM C 150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
   2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.

3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by topping manufacturer.
4. Compressive Strength: Not less than 5000 psi at 28 days when tested according to ASTM C 109/C 109M.

2.7 CONCRETE MIXTURES - GENERAL

A. Prepare design mixes for each type and strength of concrete determined by either laboratory trial mix or field test data bases, according to ACI 301.
   1. Use a qualified independent testing agency for preparing and reporting proposed mix designs for the laboratory trial mix basis.
   2. Proportion concrete to provide an average compressive strength confirmed by historical field test data in accordance with ACI 301.
   3. When the concrete production facility does not have field strength test records for calculating the standard deviation, the required average 28-day compressive strength of the proposed mix design shall be as follows:
      a. 3,000 psi specified strength – 4,200 psi required strength.
      b. 4,000 psi specified strength – 5,200 psi required strength.
      c. 5,000 psi specified strength – 6,200 psi required strength.
      d. 6,000 psi specified strength – 7,400 psi required strength.
   4. Adjustment to the concrete mix design shall be reviewed by the Engineer and approved by the material testing agency.

B. Adjustments to the concrete mix designs shall be made to conform with the recommendations for hot weather concreting, ACI 305 and the recommendations for cold weathering concreting, ACI 306.

C. Submit written reports to Architect of each proposed mix for each class of concrete at least 15 days prior to start of work. Do not begin concrete production until mixes have been reviewed by Architect.

D. Concrete Unit Weight:
   1. Normal weight concrete shall have a fresh unit weight of 147 to 152 pcf, as determined by ASTM C138.

E. Minimum Cementitious Material Content:
   1. 1-1/2-inch nominal maximum size of aggregate: 470 lbs/yd^3.
   2. 1-inch nominal maximum size of aggregate: 520 lbs/yd^3.
   3. 3/4-inch nominal maximum size of aggregate: 540 lbs/yd^3.
   4. 1/2-inch nominal maximum size of aggregate: 590 lbs/yd^3.
   5. 3/8-inch nominal maximum size of aggregate: 610 lbs/yd^3.

F. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
   1. Fly Ash: 25 percent.

G. Maximum Water-Cementitious Material Ratio: Subject to modification by stricter criteria contained later in this section, the maximum water-cementitious material shall be:
   1. 5000 psi: 0.40.

2. 4000 psi: 0.44.
3. 3500 psi: 0.51.
4. 3000 psi: 0.58.
5. Concrete required to have low water permeability: 0.40.
    a. The following structural elements subject to this requirement are: All storage tank concrete.
6. Concrete exposed to deicers or subject to freezing and thawing while moist: 0.45.
    a. The following structural elements subject to this requirement are: All slabs-on-grade.

H. Air Content: Subject to more stringent requirements later in this section:
1. Add air-entraining admixture of manufacturer's prescribed rate to result in concrete at point of placement having an air content of 2 to 4 percent, unless otherwise noted, for interior concrete and exterior concrete not exposed to freezing or deicing chemicals.
2. Do not air entrain concrete to trowel-finished interior floors. Do not allow entrapped air content to exceed 3 percent.
3. Where referenced later in this section as severe exposure, add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an air content as follows within a tolerance of plus 1 or minus 1.5 percent, unless otherwise indicated.
    a. Air Content:
        1) 5.5 percent for 1-1/2 inch nominal maximum aggregate.
        2) 6 percent for 1-inch nominal maximum aggregate.
        3) 6 percent for 3/4 inch nominal maximum aggregate.

I. Limit water-soluble, chloride-ion content in hardened concrete by weight of cement to:
1. Reinforced concrete exposed to chloride in service: 0.15.
2. Other reinforced concrete construction: 0.30.

J. Admixtures: Use admixtures according to manufacturer's written instructions.
1. Admixtures to be used shall be approved by the mix designer and the Engineer, and shall be used in strict compliance with manufacturer's instructions.
2. Use water-reducing, high-range water-reducing, or plasticizing admixture in concrete, as required, for placement and workability.
3. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
4. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.

2.8 CONCRETE MIXTURES FOR BUILDING ELEMENTS

A. Footings: Proportion normal-weight concrete mixture as follows:
1. Minimum Compressive Strength: 4000 psi at 28 days.
2. Maximum Water-Cementitious Materials Ratio: 0.50.
3. Slump Limit: 5 inches (125 mm), plus or minus 1 inch (25 mm).
4. Air Content: As required by this section for moderate exposure.

B. Tank Walls and Base Slabs: Proportion normal-weight concrete mixture as follows:
1. Minimum Compressive Strength: 5000 psi (34.5 MPa) at 28 days.

2. Maximum Water-Cementitious Materials Ratio: 0.40.
3. Slump Limit: 8 inches (200 mm) for concrete with verified slump of 2 to 4 inches (50 to 100 mm) before adding high-range water-reducing admixture or plasticizing admixture, plus or minus 1 inch (25 mm).
4. Air Content: As required by this section for severe exposure.

C. Slab-on-Grade: Proportion normal-weight concrete mix as follows:
1. A minimum 3-day compressive strength of 1800 psi shall be confirmed by the material testing agency prior to allowing construction personnel traffic on slab surfaces. Construction equipment traffic shall not be allowed on slab surfaces prior to approval by the Engineer.
2. Minimum Compressive Strength: 4000 psi at 28 days.
3. Slump Limit: 5 inches, plus or minus 1 inch.
4. Maximum Water-Cementitious Materials Ratio: 0.48 unless noted otherwise.

D. Suspended Slabs: Proportion normal-weight concrete mixture as follows:
1. Minimum Compressive Strength: 5000 psi (34.5 MPa) at 28 days.
2. Slump Limit: 4 inches (100 mm), plus or minus 1 inch (25 mm).
3. Air Content: As required by this Section for severe exposure.

2.9 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M, and furnish batch ticket information.
1. When air temperature is between 85 and 90 deg F (30 and 32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 VAPOR RETARDERS

A. Plastic Vapor Retarder: Place, protect, and repair vapor-retarder sheets according to ASTM E 1643 and manufacturer's written instructions.
1. Lap joints six inches and seal with manufacturer's recommended tape.

3.2 JOINTS

A. Contraction (Control) Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-third of concrete thickness, as follows:
1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch(3 mm). Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch-(3-mm-) wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.

B. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
   1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface, unless otherwise indicated.
   2. Terminate full-width joint-filler strips not less than 1/2 inch(12 mm) or more than 1 inch(25 mm) below finished concrete surface where joint sealants, specified in Division 07 Section "Joint Sealants," are indicated.
   3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

3.3 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.

B. Provide and maintain pumping equipment to maintain excavation free of water prior to placing concrete.

C. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.
   1. Do not add water to concrete after adding high-range water-reducing admixtures to mix.

D. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.
   1. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures, nor 24 inches, and in a manner to avoid inclined construction joints. Place each layer while preceding layer is still plastic to avoid cold joints.
   2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
   3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches (150 mm) into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.

E. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
   1. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
   2. Maintain reinforcement in position on chairs during concrete placement.
   3. Screed slab surfaces with a straightedge and strike off to correct elevations.
   4. Slope surfaces uniformly to drains where required.
   5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.

F. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
   1. When average high and low temperature is expected to fall below 40 deg F (4.4 deg C) for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
   2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
   3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.
   4. Combustion heaters which exhaust flue gases shall be vented and the heated air shall not come into direct contact with freshly placed concrete.
   5. Submit detailed procedures for the production, transportation, placement, protection, curing, and temperature monitoring of concrete during cold weather. Include procedures to be implemented upon abrupt change of weather conditions or equipment failures.

G. Hot-Weather Placement: Comply with ACI 301, ACI 305R, Chapter 4, Placement and Curing, and as follows:
   1. Maintain concrete temperature below 90 deg F (32 deg C) at time of placement. Also follow hot-weather procedures when maximum rate of evaporation in the concrete exceeds 0.2 pounds per square foot per hour at the time of placement. The rate of evaporation shall be determined by the nomograph in ACI 305R, considering air temperature, relative humidity, concrete temperature, and wind velocity. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
   2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.
   3. Submit hot weather curing procedures and data demonstrating that proposed materials meet specifications. Include evaporation retarder product data, fogging procedures, and other protection procedures.

3.4 FINISHING FORMED SURFACES

A. Rough-Formed Finish: For formed concrete surfaces not exposed to view in the finish work or by other construction, unless otherwise indicated. As-cast concrete texture imparted by form-facing material with tie holes and defective areas repaired and patched. Remove fins and other projections exceeding ACI 347R limits for class of surface specified, or 1/2 inch, whichever is more stringent.

B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defective areas. Remove fins and other projections exceeding 1/8 inch(3 mm) in height.
   1. Apply to concrete surfaces exposed to public view, to receive a rubbed finish, or to be covered with a coating or covering material applied directly to concrete, such as waterproofing, dampproofing, veneer plaster, or painting.

C. Rubbed Finish: Apply the following to smooth-formed finished concrete:
   1. Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete scheduled surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.

D. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

3.5 FINISHING FLOORS AND SLABS

A. General: Comply with recommendations in ACI 302.1R for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture.
   1. Apply float finish to surfaces indicated, to surfaces to receive trowel finish, and to floor and slab surfaces to be covered with fluid-applied or sheet waterproofing, built-up or membrane roofing, or sand-bed terrazzo.

C. Trowel Finish: After applying float finish, apply first trowel finish and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
   1. Apply a trowel finish to surfaces indicated and to floor and slab surfaces exposed to view or to be covered with carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin film-finish coating system
   2. Finish surfaces to the following tolerances, measured within 24 hours according to ASTM E 1155/E 1155M for a randomly trafficked floor surface:
      a. Specified overall values of flatness, F(F) 30; and levelness, F(L) 20; with minimum local values of flatness, F(F) 24; and levelness, F(L) 15; for suspended slabs.

D. Broom Finish: Apply a broom finish to upper tank slab exterior concrete platforms, steps, and ramps, and elsewhere as indicated.
   1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Architect before application.

3.6 MISCELLANEOUS CONCRETE ITEMS

A. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

B. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on Drawings. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates of manufacturer furnishing machines and equipment.

C. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items. Cast-in inserts and accessories as shown on Drawings. Screed, tamp, and trowel-finish concrete surfaces.

D. Non-Shrink Grout: All equipment bases, and other locations noted on the drawings shall be grouted with the specified non-shrink grout.

3.7 CONCRETE PROTECTION AND CURING

A. General: Begin curing procedures immediately following the commencement of the finishing operation. Cure concrete in accordance with ACI 308.1. Protect freshly placed concrete from premature drying.
   1. Comply with ACI 306.1 for cold weather protection. Immediately after placement, protect the concrete from excessively cold temperatures. Maintain concrete protection to prevent freezing of the concrete and to ensure the necessary strength development for the durations specified in ACI 306.1. Remove protection in such a manner so that the maximum decrease in temperature does not exceed the limits specified in ACI 301.
   2. Comply with ACI 301 for hot-weather protection during curing. Follow the recommendations in ACI 308 and Chapter 4 of ACI 305R for initial, intermediate, and final curing, as well as recommended curing durations.

B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb.(sq. ft. x h)(1 kg/(sq.m x h)) before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period.
   1. All exposed surfaces shall be cured for no less than seven days.

D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.

E. Cure concrete according to ACI 308.1, by one or a combination of the following methods:
   1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
      a. Water.
      b. Continuous water-fog spray.
      c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch(300-mm) lap over adjacent absorptive covers.
   2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends

lapped at least 12 inches(300 mm), and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.
   a. After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer.
4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

3.8 JOINT FILLING

A. Prepare, clean, and install joint filler according to manufacturer's written instructions.
   1. Defer joint filling until concrete has aged at least six months. Do not fill joints until construction traffic has permanently ceased.

B. Remove dirt and debris from joints. Joints shall be dry and free from all substances that inhibit bond. Install sealant to prevent three-sided bonding. Coordinate sealant installation with the application of flooring.

C. Install semirigid epoxy joint filler full depth in saw-cut joints and at least 2 inches(50 mm) deep in formed joints. Overfill joint and trim joint filler flush with top of joint after hardening.

3.9 CONCRETE SURFACE REPAIRS

A. Submit repair procedure for review prior to the commencement of any repair operations. Include removal techniques, surface preparation, patching techniques, materials and equipment. Allow for specified review period for submittals.

B. Defective Concrete: Repair and patch defective areas when the tolerances specified for the formwork are exceeded or when approved by the Architect. Remove and replace concrete that cannot be repaired and patched to Architect's approval.

C. Removal:
   1. Continue to remove defective concrete until aggregate is being broken instead of being dislodged.
   2. Where concrete has been removed by means such as blasting or impacting, the concrete left in place shall be prepared using a secondary method such as chipping, abrasive blasting, or high-pressure water-jetting to remove any damaged surface material.
   3. Remove concrete to at least one inch behind reinforcing steel.
   4. Exposed reinforcing steel shall be inspected by the Testing Agency prior to the commencement of patching operations.

D. Patching Material: Submit manufacturer's information for each proposed product and application. Submittal must include intended use.

E. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, including the bottom surface of exposed slabs, and stains and other discolorations that cannot be removed by cleaning.
   1. Immediately after form removal, cut out honeycombs, rock pockets, and voids at least 1/2 inch(12 mm) in any dimension beyond the defect in solid concrete and not less than 1 inch(25 mm) in depth. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill with patching material before bonding agent has dried. Fill form-tie voids with patching material or cone plugs secured in place with bonding agent.
   2. Repair defects on surfaces exposed to view so that, when dry, patching material will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching.
   3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Architect.

F. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
   1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch(0.25 mm) wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
   2. After concrete has cured at least 14 days, correct high areas by grinding.
   3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching material. Finish repaired areas to blend into adjacent concrete.
   4. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch(6 mm) to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
   5. Repair defective areas, except random cracks and single holes 1 inch(25 mm) or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least 1 inch(25 mm) clearance all around. Blend patching material with adjacent finished concrete.
   6. Repair random cracks and single holes 1 inch(25 mm) or less in diameter with patching material. V-groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.

G. Perform all other concrete repairs, such as structural repairs, using a patching material or materials intended for the specific instance, approved by the Architect.

H. Repair materials and installation not specified above may be used, subject to Architect's approval.

3.10 FIELD QUALITY CONTROL

A. Materials and operations shall be tested and inspected as work progresses. Failure to detect defective work shall not prevent rejection when defect is discovered, nor shall it obligate the Owner for final acceptance.

B. Testing and Inspecting: Owner will engage a special inspector and qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.

C. Inspections: As required by the Division 01 for the following:
1. Steel reinforcement placement.
2. Steel reinforcement welding.
3. Verification of use of required design mixture.
4. Concrete placement, including conveying and depositing.
5. Curing procedures and maintenance of curing temperature.
6. Verification of concrete strength before removal of shores and forms from beams and slabs.

D. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
1. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd.(76 cu. m) or fraction thereof of each concrete mix placed each day, nor less than once for each 5,000 square feet of concrete.
    a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mix, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
2. Cold Weather: At least three specimens shall be taken for each two hours of entire placing or for each 100 yards^3, whichever is greater, during cold weather and cured on site under same conditions as concrete placed that day. The number of specimens shall not be less than specified elsewhere. Make cylinders at the middle of the concrete load.
3. Slump: ASTM C 143; one test for each concrete load at point of delivery if not pumped, point of placement if pumped and one for each compressive strength test specimen taken at the middle of the load at the point of discharge. Perform additional tests when concrete consistency appears to change.
4. Air Content: ASTM C 231, pressure method, for normal-weight concrete; ASTM C 173, volumetric method, for structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mix. Take samples at point of discharge at the same time the cylinders are made.
5. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F(4.4 deg C) and below and when 80 deg F(27 deg C) and above, and one test for each composite sample.
6. Unit Weight: Fresh unit weight of normal weight structural concrete, one test for each composite sample, but not less than one test for each day's pour of each concrete mix.
7. Compression Test Specimens: Comply with ACI 318, Chapter 5 and ASTM C 31/C 31M; cast and laboratory cure one set of four standard cylinder specimens for each composite sample.

a. Cast and field cure one set of two standard cylinder specimens for each composite sample.

8. Compressive-Strength Tests: ASTM C 39.
   a. Test two field-cured specimens at 7 days.
   b. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at age indicated.

9. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
10. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi (3.4 MPa).
11. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
12. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.
13. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect. Testing and inspecting agency will conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42/C 42M or by other methods as directed by Architect, at no less than 29 days if the specified compressive strengths are not met at 28 days. The tests will not be used as the sole basis for acceptance.
14. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
15. Correct deficiencies in the Work that test reports and inspections indicate dos not comply with the Contract Documents.

E. Measure floor and slab flatness and levelness according to ASTM E 1155 (ASTM E 1155M) within 24 hours of finishing.

F. Mechanical Reinforcing Bar Splices:
   1. A minimum of one coupler and reinforcing bar assembly shall be tested for each size and coupler to be used on the Project.
   2. Testing shall be conducted on the basis of tensile loading of the coupled reinforcing through the yield point and to complete failure.
   3. Written test results shall include the value of 125 percent of the theoretical yield point of the reinforcing being tested, indication of no failure of the coupler at this point, and the tensile strength at which the reinforcing and coupler assembly failed.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes:
   1. Precast structural concrete.

B. Related Sections:
   1. Division 03 Section "Cast-in-Place Concrete" for placing connection anchors in concrete.
   2. Division 04 Section "Unit Masonry" for inserts or anchorages required for precast concrete slab connections.

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design precast structural concrete, including comprehensive engineering analysis by a qualified professional engineer registered in the state of the project, using performance requirements and design criteria indicated.

B. Structural Performance: Provide precast structural concrete units and connections capable of withstanding the following design loads within limits and under conditions indicated:
   1. Dead Loads: Self weight of roof plus 5 psf collateral load.
   2. Roof Loads: 20 psf.
   3. Wind Loads:
      a. Basic Wind Speed: 90 mph.
      b. Importance Factor: 1.15.
      c. Exposure Category: B.
   4. Seismic Loads:
      a. S_{ds} = 0.26.
      b. S_{di} = 0.1.
      c. Site Class: B.
      d. Importance Factor: 1.25.
   5. Design precast structural concrete framing system and connections to maintain clearances at openings, to allow for fabrication and construction tolerances, to accommodate live-load deflection, shrinkage and creep of primary building structure, and other building movements. Maintain precast structural concrete deflections within limits of ACI 318 (ACI 318M).
      a. Thermal Movements: Allow for in-plane thermal movements resulting from annual ambient temperature changes of minus 18 to plus 120 deg F (minus 10 to plus 67 deg C).
   6. Fire-Resistance Rating: Select material and minimum thicknesses to provide indicated fire rating.

C. Maximum Allowable Deflection: 1/240 span.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Design Mixes: For each concrete mixture.

C. Shop Drawings: Indicate member locations, plans, elevations, dimensions, shapes, cross sections, openings, and types of reinforcement, including special reinforcement. Detail fabrication and installation of precast structural concrete units.
   1. Comprehensive engineering analysis signed and sealed by the qualified professional engineer, licensed in the state where the Project is located, responsible for its preparation.
   2. Indicate joints, reveals, and extent and location of each surface finish.
   3. Indicate separate face and backup mixture locations and thicknesses.
   4. Indicate welded connections by AWS standard symbols. Show size, length, and type of each weld.
   5. Detail loose and cast-in hardware, lifting and erection inserts, connections, and joints.
   6. Indicate locations, tolerances, and details of anchorage devices to be embedded in or attached to structure or other construction.
   7. Include and locate openings larger than by 10 inches (250 mm).
   8. Indicate location of each precast structural concrete unit by same identification mark placed on panel.
   9. Indicate relationship of precast structural concrete units to adjacent materials.
   10. Indicate locations and details of brick units, including corner units and special shapes, and joint treatment.
   11. Indicate locations and details of stone facings, anchors, and joint widths.
   12. Indicate estimated camber for precast floor slabs with concrete toppings.
   13. Indicate shim sizes and grouting sequence.
   14. Design Modifications: If design modifications are proposed to meet performance requirements and field conditions, submit design calculations and Shop Drawings. Do not adversely affect the appearance, durability, or strength of units when modifying details or materials and maintain the general design concept.

D. Qualification Data: For installer. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

E. Welding Certificates: Copies of certificates for welding procedures and personnel.

F. Material Test Reports: For aggregates.

G. Material Certificates: Signed by manufacturers certifying that each of the following items complies with requirements:
   1. Cementitious materials.
   2. Reinforcing materials and prestressing tendons.
   3. Admixtures.
   4. Bearing pads.

H. Source quality-control reports.

I. Field quality-control and special inspection reports.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed precast structural concrete work similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

B. Fabricator Qualifications: A firm that assumes responsibility for engineering precast structural concrete units to comply with performance requirements. Responsibility includes preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer licensed in the state where the Project is located.
   1. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of precast structural concrete that are similar to those indicated for this Project in material, design, and extent.
   2. Participates in PCI's Plant Certification program at time of bidding and is designated a PCI-certified plant as follows:
      a. Group C, Category C1 - Precast Concrete Products (no prestressed reinforcement).

C. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 to conduct the testing indicated, as documented according to ASTM E 548.

D. Design Standards: Comply with ACI 318(ACI 318M) and the design recommendations of PCI MNL 120, "PCI Design Handbook--Precast and Prestressed Concrete."

E. Quality-Control Standard: For manufacturing procedures and testing requirements, quality-control recommendations, and camber and dimensional tolerances for types of units required, comply with PCI MNL 116, "Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products."

F. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel"; and AWS D1.4, "Structural Welding Code--Reinforcing Steel."

G. Preinstallation Conference: Conduct conference at Project site one week prior to commencing work of this section to comply with requirements in Division 01 Section "Project Management and Coordination".

1.6 DELIVERY, STORAGE, AND HANDLING

A. Support units during shipment on nonstaining shock-absorbing material in same position as during storage.

B. Store units with adequate bracing and protect units to prevent contact with soil, to prevent staining, prevent cracking, distortion, warping, or other physical damage.
   1. Store units with dunnage across full width of each bearing point unless otherwise indicated.
   2. Place adequate dunnage of even thickness between each unit.
   3. Place stored units so identification marks are clearly visible, and units can be inspected.

C. Handle and transport units in a position consistent with their shape and design in order to avoid excessive stresses that would cause cracking or damage.

D. Lift and support units only at designated points shown on Shop Drawings.

1.7 COORDINATION

A. Furnish anchorage items to be embedded in other construction without delaying the Work. Provide setting diagrams, templates, instructions, and directions, as required, for installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Fabricators: Subject to compliance with requirements, available fabricators offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. deAM-RON Building Systems, LLC.
   2. Sequatchie Concrete Services, Inc.
   3. Or approved equal.

2.2 MOLD MATERIALS

A. Molds: Rigid, dimensionally stable, non-absorptive material, warp and buckle free, that will provide continuous and true precast concrete surfaces within fabrication tolerances indicated; nonreactive with concrete and suitable for producing required finishes.
   1. Mold-Release Agent: Commercially produced liquid-release agent that will not bond with, stain or adversely affect precast concrete surfaces and will not impair subsequent surface or joint treatments of precast concrete.

B. Form Liners: Units of face design, texture, arrangement, and configuration indicated. Furnish with manufacturer's recommended liquid-release agent that will not bond with, stain, or adversely affect precast concrete surfaces and will not impair subsequent surface or joint treatments of precast concrete.

C. Surface Retarder: Chemical set retarder, capable of temporarily delaying final hardening of newly placed concrete mixture to depth of reveal specified.

2.3 REINFORCING MATERIALS

A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60(Grade 420), deformed.

B. Low-Alloy-Steel Reinforcing Bars: ASTM A 706/A 706M, deformed.

C. Galvanized Reinforcing Bars: ASTM A 615/A 615M, Grade 60(Grade 420), deformed bars, ASTM A 767/A 767M, Class II zinc coated, hot-dip galvanized after fabrication and bending, and chromate wash treated after fabrication and bending.

D. Supports: Manufacturer's bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place according to CRSI's "Manual of Standard Practice," PCI MNL 116, and as follows:
1. For uncoated reinforcement, use all-plastic, CRSI Class 1 plastic-protected bar supports.

2.4 CONCRETE MATERIALS

A. Portland Cement: Gray, ASTM C 150, Type I or Type III, of same type, brand, and source.

B. Supplementary Cementitious Materials:
1. Fly Ash: ASTM C 618, Class C or F, with maximum loss on ignition of 3 percent.
2. Metakaolin Admixture: ASTM C 618, Class N.
3. Silica Fume Admixture: ASTM C 1240, with optional chemical and physical requirement.
4. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.

C. Lightweight Aggregates: Except as modified by PCI MNL 116, ASTM C 330, with absorption less than 11 percent.

D. Water: Potable; free from deleterious material that may affect color stability, setting, or strength of concrete and complying with chemical limits of PCI MNL 116.

E. Air-Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with other required admixtures.

F. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and to not contain calcium chloride, or more than 0.15 percent chloride ions or other salts by weight of admixture.
1. Water-Reducing Admixtures: ASTM C 494/C 494M, Type A.
2. Retarding Admixture: ASTM C 494/C 494M, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
4. Water-Reducing and Accelerating Admixture: ASTM C 494/C 494M, Type E.
5. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
6. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
7. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M.

G. Corrosion-Inhibiting Admixture: Commercially formulated, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete.

2.5 STEEL CONNECTION MATERIALS

A. Carbon-Steel Shapes and Plates: ASTM A 36/A 36M.

B. Carbon-Steel Headed Studs: ASTM A 108, AISI 1018 through AISI 1020, cold finished; AWS D1.1, Type A or B, with arc shields and with minimum mechanical properties of PCI MNL 116.

C. Carbon-Steel Bolts and Studs: ASTM A 307, Grade A(ASTM F 568M, Property Class 4.6); carbon-steel, hex-head bolts and studs; carbon-steel nuts ASTM A563; and flat, unhardened steel washers, ASTM F844.

D. Welding Electrodes: Comply with AWS standards.

E. Accessories: Provide clips, hangers, plastic shims, and other accessories required to install precast structural concrete units.

2.6 BEARING PADS

A. Provide one of the following bearing pads for precast structural concrete units as recommended by precast fabricator for application:
   1. Elastomeric Pads: AASHTO M 251, plain, vulcanized, 100 percent polychloroprene (neoprene) elastomer, molded to size or cut from a molded sheet, 50 to 70 Shore A durometer, minimum tensile strength 2250 psi(15.5 MPa) per ASTM D 412.
   2. Random-Oriented, Fiber-Reinforced Elastomeric Pads: Preformed, randomly oriented synthetic fibers set in elastomer. Surface hardness of 70 to 90 Shore A durometer, ASTM D2240; capable of supporting a compressive stress of 3000 psi with no cracking, splitting, or delaminating in the internal portions of pad. Test one specimen for every 200 pads used in project.
   3. Cotton-Duck-Fabric-Reinforced Elastomeric Pads: Preformed, horizontally layered cotton-duck fabric bonded to an elastomer. Surface hardness of 80 to 100 Shore A durometer, ASTM D2240; complying with AASHTO's "AASHTO Load and Resistance Factor Design (LRFD) Bridge Specifications", Division II, Section 18.10.2; or with MIL-C-882E.
   4. Frictionless Pads: Tetrafluoroethylene, glass-fiber reinforced, bonded to mild-steel plate, of type required for in-service stress.

2.7 GROUT MATERIALS

A. Sand-Cement Grout: Portland cement, ASTM C 150, Type I, and clean, natural sand, ASTM C 144. Mix at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.

B. Nonmetallic, Nonshrink Grout: Premixed, nonmetallic, noncorrosive, nonstaining grout containing selected silica sands, portland cement, shrinkage-compensating agents, plasticizing and water-reducing agents, complying with ASTM C 1107, Grade A for drypack and Grades B and C for flowable grout and of consistency suitable for application within a 30-minute working time. Minimum yield strength of 10,000 psi at 28 days.

2.8 CONCRETE MIXTURES

A. Prepare design mixes for each type of precast concrete required.
   1. Limit use of fly ash to 25 percent of portland cement by weight and granulated blast-furnace slag to 40 percent of portland cement by weight; metakaolin and silica fume to 10 percent of Portland cement by weight.

B. Design mixes may be prepared by a qualified independent testing agency or by qualified precast plant personnel at precast structural concrete fabricator's option.

C. Limit water-soluble chloride ions to the maximum percentage by weight of cement permitted by ACI 318(ACI 318M) or PCI MNL 116 when tested according to ASTM C1218.

D. Water Absorption: 6 percent by weight or 14 percent by volume, tested according to PCI MNL 116.

E. Lightweight Concrete Mixtures: Proportion mixes by either laboratory trial batch or field test data methods according to ACI 211.2, with materials to be used on Project, to provide lightweight concrete with the following properties:
   1. Compressive Strength (28 Days): 4000 psi.
   2. Unit Weight: Calculated equilibrium unit weight of 115 lb/cu. ft.(1842 kg/cu. m), plus or minus 3 lb/cu. ft.(48 kg/cu. m), according to ASTM C 567.
   3. Add air-entraining admixture at manufacturer's prescribed rate to result in lightweight concrete at point of placement having an air content complying with PCI MNL 116.

F. When included in design mixtures, add other admixtures, such as water-reducing, high-range water-reducing, water-reducing and accelerating, or water-reducing and retarding admixtures, according to manufacturer's written instructions.

G. Concrete Mix Adjustments: Concrete mix design adjustments may be proposed if characteristics of materials, Project conditions, weather, test results, or other circumstances warrant.

2.9 MOLD FABRICATION

A. Molds: Accurately construct molds, mortar tight, of sufficient strength to withstand pressures due to concrete-placement operations and temperature changes and for prestressing and detensioning operations. Coat contact surfaces of molds with release agent before reinforcement is placed. Avoid contamination of reinforcement and prestressing tendons by release agent.

B. Maintain molds to provide completed precast structural concrete units of shapes, lines, and dimensions indicated, within fabrication tolerances specified.
   1. Edge and Corner Treatment: Uniformly chamfered.

2.10 FABRICATION

A. Cast-in Anchors, Inserts, Plates, Angles, and Other Anchorage Hardware: Fabricate anchorage hardware with sufficient anchorage and embedment to comply with design

requirements. Accurately position for attachment of loose hardware, and secure in place during precasting operations. Locate anchorage hardware where it does not affect position of main reinforcement or concrete placement.

1. Weld-headed studs and deformed bar anchors used for anchorage according to AWS D1.1/D1.1M and AWS C5.4, "Recommended Practices for Stud Welding."

B. Furnish loose hardware items including steel plates, clip angles, seat angles, anchors, dowels, cramps, hangers, and other hardware shapes for securing precast structural concrete units to supporting and adjacent construction.

C. Cast-in reglets, slots, holes, and other accessories in precast structural concrete units as indicated on the Contract Drawings.

D. Reinforcement: Comply with recommendations in PCI MNL 116 for fabricating, placing, and supporting reinforcement.

1. Clean reinforcement of loose rust and mill scale, earth, and other materials that reduce or destroy the bond with concrete. When damage to epoxy-coated reinforcement exceeds limits specified, repair with patching material compatible with coating material and epoxy coat bar ends after cutting.
2. Accurately position, support, and secure reinforcement against displacement during concrete-placement and consolidation operations. Completely conceal support devices to prevent exposure on finished surfaces.
3. Place reinforcement to maintain at least 3/4-inch (19-mm) minimum coverage. Increase cover requirements according to ACI 318 (ACI 318M) when units are exposed to corrosive environment or severe exposure conditions. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position while placing concrete. Direct wire tie ends away from finished, exposed concrete surfaces.
4. Place reinforcing steel and prestressing strand to maintain at least 3/4-inch (19-mm) minimum concrete cover. Increase cover requirements for reinforcing steel to 1-1/2 inches (38 mm) when units are exposed to corrosive environment or severe exposure conditions. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position while placing concrete. Direct wire tie ends away from finished, exposed concrete surfaces.
5. Install welded wire fabric in lengths as long as practicable. Lap adjoining pieces at least one full mesh spacing and wire tie laps, where required by design. Offset laps of adjoining widths to prevent continuous laps in either direction.

E. Reinforce precast structural concrete units to resist handling, transportation, and erection stresses.

F. Comply with requirements in PCI MNL 116 and in this Section for measuring, mixing, transporting, and placing concrete. After concrete batching, no additional water may be added.

G. Place concrete in a continuous operation to prevent seams or planes of weakness from forming in precast concrete units.

H. Thoroughly consolidate placed concrete by internal and external vibration without dislocating or damaging reinforcement and built-in items. Use equipment and procedures complying with PCI MNL 116.

I. Comply with ACI 306.1 procedures for cold-weather concrete placement.

J. Comply with PCI MNL 116 recommendations for hot-weather concrete placement.

K. Identify pickup points of precast concrete units and orientation in structure with permanent markings, complying with markings indicated on Shop Drawings. Imprint casting date on each precast concrete unit on a surface that will not show in finished structure.

L. Cure concrete according to requirements of PCI MNL 116, by moisture retention without heat or by accelerated heat curing using low-pressure live steam or radiant heat and moisture. Cure units until compressive strength is high enough to ensure that stripping does not have an effect on performance or appearance of final product.

M. Discard and replace precast structural concrete units that do not comply with requirements, including structural, manufacturing tolerance, and appearance, unless repairs meet requirements in PCI MNL 116 and meet Architect's approval.

2.11 FABRICATION TOLERANCES

A. Fabricate precast structural concrete units straight and true to size and shape with exposed edges and corners precise and true so each finished unit complies with PCI MNL 116 product dimension tolerances.

2.12 COMMERCIAL FINISHES

A. Finish formed surfaces of precast structural concrete as indicated for each type of unit, and as follows:

B. Standard Grade: Normal plant-run finish produced in molds that impart a smooth finish to concrete. Surface holes smaller than 1/2 inch (13 mm) caused by air bubbles, normal color variations, form joint marks, and minor chips and spalls are permitted. Fill air holes greater than 1/4 inch (6 mm) in width that occur more than once per 2 sq. in (1300 sq. mm). Major or unsightly imperfections, honeycombs, or structural defects are not permitted. Limit joint offsets to 1/8 inch (3 mm).

C. Screed or float finish unformed surfaces. Strike off and consolidate concrete with vibrating screeds to a uniform finish. Hand screed at projections. Normal color variations, minor indentations, minor chips, and spalls are permitted. Major imperfections, honey-combing, or defects are not permitted.

D. Exposed Ends at Stressing Tendons: Fill recess with non-shrink grout, trowel flush.

E. Core Hole End Plugs: Cardboard insert and concrete fill.

2.13 HOLLOW-CORE SLAB UNITS

A. Type: Precast, prestressed concrete units with open, hollow cores running the full length of the slab units.

B. Furnish units free of voids and honeycombs.

C. Provide standard finish to precast concrete units.

D. Reinforce units to resist transportation and erection stresses.

E. Include cast-in weld plates where required.

F. Coordinate with other trades for installation of cast-in items.

2.14 SOURCE QUALITY CONTROL

A. Owner will employ an independent testing agency to evaluate precast structural concrete fabricator's quality-control and testing methods.
   1. Allow Owner's testing agency access to material storage areas, concrete production equipment, concrete placement, and curing facilities. Cooperate with Owner's testing agency and provide samples of materials and concrete mixes as may be requested for additional testing and evaluation.

B. Testing: Test and inspect precast concrete according to PCI MNL 116 requirements.

C. Strength of precast concrete units will be considered deficient if units fail to comply with ACI 318 requirements, including the following:
   1. Units fail to comply with compressive-strength test requirements.
   2. Reinforcement and prestressed tendons of units do not comply with fabrication requirements.
   3. Concrete curing and protection of units against extremes in temperature fail to comply with requirements.
   4. Units are damaged during handling and erecting.

D. If there is evidence that the strength of precast concrete units may be deficient or may not comply with ACI 318 requirements, employ an independent testing agency to obtain, prepare, and test cores drilled from hardened concrete to determine compressive strength according to ASTM C 42.
   1. A minimum of three representative cores will be taken from units of suspect strength, from locations directed by Architect.
   2. Cores will be tested, after immersion in water, in a wet condition per ACI 301 if units will be wet under service conditions.
   3. Cores will be tested in an air-dry condition per ACI 301 if units will be dry under service conditions.

4. Strength of concrete for each series of 3 cores will be considered satisfactory if the average compressive strength is equal to at least 85 percent of the 28-day design compressive strength and no single core is less than 75 percent of the 28-day design compressive strength.
5. Test results will be made in writing on the same day that tests are performed, with copies to Architect, Contractor, and precast concrete fabricator. Test reports will include the following:
    a. Project identification name and number.
    b. Date when tests were performed.
    c. Name of precast concrete fabricator.
    d. Name of concrete testing agency.
    e. Identification letter, name, and type of precast concrete unit or units represented by core tests; design compressive strength; type of break; compressive strength at break, corrected for length-diameter ratio; and direction of applied load to core in relation to horizontal plane of concrete as placed.

E. Patching: If core test results are satisfactory and precast concrete units comply with requirements, clean and dampen core holes and solidly fill with precast concrete mix that has no coarse aggregate, and finish to match adjacent precast concrete surfaces.

F. Dimensional Tolerances: Units with dimensions smaller or larger than required and not complying with tolerance limits may be subject to additional testing.
1. Precast concrete units with dimensions larger than required will be rejected if the appearance or function of the structure is adversely affected or if larger dimensions interfere with other construction. Repair or remove and replace rejected units, as required, to comply with construction conditions.

G. Defective Units: Discard and replace precast structural concrete units that do not comply with requirements, including strength, manufacturing tolerances, and color and texture range. Chipped, spalled, or cracked units may be repaired, subject to Architect's approval. Architect reserves the right to reject precast units that do not match approved samples, sample panels, and mockups.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting structural frame or foundation and conditions for compliance with requirements for installation tolerances, true and level bearing surfaces, and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. Do not install precast concrete units until supporting, cast-in-place, building structural framing has attained minimum allowable design compressive strength or until supporting steel or other structure is complete.

3.2 INSTALLATION

A. Install clips, hangers, bearing pads, and other accessories required for connecting precast structural concrete units to supporting members and backup materials.

B. Erect precast structural concrete level, plumb, and square within specified allowable tolerances. Provide temporary structural framing, supports, and bracing as required to maintain position, stability, and alignment of units until permanent connection.
   1. Install temporary steel or plastic spacing shims or bearing pads as precast structural concrete units are being erected. Tack weld steel shims to each other to prevent shims from separating.
   2. Maintain horizontal and vertical joint alignment and uniform joint width as erection progresses.
   3. Remove projecting lifting devices and grout fill voids within recessed lifting devices flush with surface of adjacent precast surfaces when recess is exposed.

C. Connect precast structural concrete units in position by bolting, welding, grouting, or as otherwise indicated on Shop Drawings. Remove temporary shims, wedges, and spacers as soon as practical after connecting and grouting are completed.
   1. Do not permit connections to disrupt continuity of roof flashing.

D. Field cutting of precast units is not permitted without approval of the Architect.

E. Fasteners: Do not use drilled or powder-actuated fasteners for attaching accessory items to precast, prestressed concrete units.

F. Welding: Comply with applicable AWS D1.1/D1.1M and AWS D1.4 for welding, welding electrodes, appearance, quality of welds, and methods used in correcting welding work.
   1. Protect precast structural concrete units and bearing pads from damage by field welding or cutting operations, and provide noncombustible shields as required.
   2. Clean weld-affected steel surfaces with chipping hammer followed by brushing, and reprime damaged painted surfaces.
   3. Remove, reweld, or repair incomplete and defective welds.

G. At bolted connections, use lock washers, tack welding, or other approved means to prevent loosening of nuts after final adjustment.
   1. Where slotted connections are used, verify bolt position and tightness. For sliding connections, properly secure bolt but allow bolt to move within connection slot. For friction connections, apply specified bolt torque and check 25 percent of bolts at random by calibrated torque wrench.

H. Grouting: Grout connections and joints and open spaces at keyways, connections, and joints where required or indicated on Shop Drawings. Retain grout in place until hard enough to support itself. Pack spaces with stiff grout material, tamping until voids are completely filled.
   1. Place grout to finish smooth, level, and plumb with adjacent concrete surfaces.
   2. Fill joints completely without seepage to other surfaces.
   3. Trowel top of grout joints on roofs smooth and uniform. Finish transitions between different surface levels not steeper than 1 to 12.

4. Place grout end cap or dam in voids at ends of hollow-core slabs.
5. Promptly remove grout material from exposed surfaces before it affects finishes or hardens.
6. Keep grouted joints damp for not less than 24 hours after initial set.

3.3 ERECTION TOLERANCES

A. Erect precast structural concrete units level, plumb, square, true, and in alignment without exceeding the noncumulative erection tolerances of PCI MNL 135.

B. Minimize variations between adjacent slab members by jacking, loading, or other method recommended by fabricator and approved by Architect.

3.4 FIELD QUALITY CONTROL

A. Testing: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections.

B. Field welds and connections using high-strength bolts will be subject to tests and inspections.

C. Testing agency will report test results promptly and in writing to Contractor and Architect.

D. Remove and replace work that does not comply with specified requirements.

E. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of corrected work with specified requirements.

3.5 REPAIRS

A. Repair precast structural concrete units if permitted by Architect.
1. Repairs may be permitted if structural adequacy, serviceability, durability, and appearance of units has not been impaired.

B. Mix patching materials and repair units so cured patches blend with color, texture, and uniformity of adjacent exposed surfaces and show no apparent line of demarcation between original and repaired work, when viewed in typical daylight illumination from a distance of 20 feet (6 m).

C. Wire brush, clean, and paint damaged prime-painted components with same type of shop primer.

D. Remove and replace damaged precast structural concrete units that cannot be repaired or when repairs do not comply with requirements as determined by Architect.

3.6 CLEANING

A. Clean mortar, plaster, fireproofing, weld slag, and other deleterious material from concrete surfaces and adjacent materials immediately.

B. Clean exposed surfaces of precast concrete units after erection and completion of joint treatment to remove weld marks, other markings, dirt, and stains.
   1. Perform cleaning procedures, if necessary, according to precast concrete fabricator's written recommendations. Clean soiled precast concrete surfaces with detergent and water, using stiff fiber brushes and sponges, and rinse with clean water. Protect other work from staining or damage due to cleaning operations.
   2. Do not use cleaning materials or processes that could change the appearance of exposed concrete finishes or damage adjacent materials.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and install grout complete as shown on the Drawings and as specified herein.

1.3 RELATED WORK

A. Division 03 Section "Concrete Formwork".

B. Division 03 Section "Concrete Reinforcement".

C. Division 03 Section "Concrete Joints and Joint Accessories".

D. Division 03 Section "Cast-in-Place Concrete".

1.4 SUBMITTALS

A. Submit to the Engineer, in accordance with Division 01 Section "Submittal Procedures", shop drawings and product data showing materials of construction and details of installation for:
   1. Commercially manufactured non-shrink cementitious grout. The submittal shall include catalog cuts, technical data, storage requirements, product life, working time after mixing, temperature considerations, conformity to required ASTM standards and Material Safety Data Sheet.
   2. Commercially manufactured non-shrink epoxy grout. The submittal shall include catalog cuts, technical data, storage requirements, product life, working time after mixing, temperature considerations, conformity to required ASTM standards and Material Safety Data Sheet.
   3. Cement grout. The submittal shall include the type and brand of the cement, the gradation of the fine aggregate, product data on any proposed admixtures and the proposed mix of the grout.
   4. Concrete grout. The submittal shall include data as required for concrete as delineated in Division 03 Section "Cast-in-Place Concrete". This includes the mix design, constituent quantities per cubic yard and the water/cement ratio.

B. Laboratory Test Reports
   1. Submit laboratory test data as required under Division 01 Section "Demonstration and Training" for concrete to be used as concrete grout.

C. Certifications: Certify that commercially manufactured grout products and concrete grout admixtures are suitable for use in contact with potable water after 30 days curing.

1.5 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM)
   1. ASTM C531 - Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical Resistant Mortars, Grouts and Monolithic Surfacings and Polymer Concretes
   2. ASTM C579 - Standard Test Method for Compressive Strength of Chemical Resistant Mortars, Grouts and Monolithic Surfacings and Polymer Concretes
   3. ASTM C827 - Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens from Cementitious Mixtures
   4. ASTM C1107 - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non-shrink)

B. U.S. Army Corps of Engineers Standard (CRD): CRD C-621 - Corps of Engineers Specification for Non-shrink Grout

C. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.6 QUALITY ASSURANCE

A. Qualifications: Grout manufacturer shall demonstrate experience with the supply and successful operation of the type of grout proposed for the work.

B. Pre-installation Conference: Well in advance of grouting, hold a pre-installation meeting to review the requirements for surface preparation, mixing, placing and curing procedures for each product proposed for use. Parties concerned with grouting shall be notified of the meeting at least 10 days prior to its scheduled date.

C. Services of Manufacturer's Representative: A qualified field technician of the non-shrink grout manufacturer, specifically trained in the installation of the products, shall attend the pre-installation conference and shall be present for the initial installation of each type of non-shrink grout. Additional services shall also be provided, as required, to correct installation problems.

D. Field Testing
   1. All field testing and inspection services required shall be provided by the Owner. The Contractor shall assist in the sampling of materials and shall provide any ladders, platforms, etc, for access to the work. The methods of testing shall comply in detail with the applicable ASTM Standards.

1.7 DELIVERY, STORAGE AND HANDLING

A. Deliver materials to the jobsite in original, unopened packages, clearly labeled with the manufacturer's name, product identification, batch numbers and printed instructions.

B. Store materials in full compliance with the manufacturer's recommendations. Total storage time from date of manufacture to date of installation shall be limited to 6 months or the manufacturer's recommended storage time, whichever is less.

C. Material which becomes damp or otherwise unacceptable shall be immediately removed from the site and replaced with acceptable material at no additional expense to the Owner.

D. Non-shrink cement-based grouts shall be delivered as preblended, prepackaged mixes requiring only the addition of water.

E. Non-shrink epoxy grouts shall be delivered as pre-measured, prepackaged, three component systems requiring only blending as directed by the manufacturer.

1.8 DEFINITIONS

A. Non-shrink Grout: A commercially manufactured product that does not shrink in either the plastic or hardened state, is dimensionally stable in the hardened state and bonds to a clean base plate.

PART 2 - PRODUCTS

2.1 GENERAL

A. The use of a manufacturer's name and product or catalog number is for the purpose of establishing the standard of quality desired.

B. Like materials shall be the products of one manufacturer or supplier in order to provide standardization of appearance.

2.2 MATERIALS

A. Non-shrink Cementitious Grout
   1. Non-shrink cementitious grouts shall meet or exceed the requirements of ASTM C1107, Grades B or C and CRD C-621. Grouts shall be Portland cement based, contain a pre-proportioned blend of selected aggregates and shrinkage compensating agents and shall require only the addition of water. Non-shrink cementitious grouts shall not contain expansive cement or metallic particles. The grouts shall exhibit no shrinkage when tested in conformity with ASTM C827.
      a. General purpose non-shrink cementitious grout shall conform to the standards stated above and shall be SikaGrout 212 by Sika Corp.; Set Grout by Master Builders, Inc.; Gilco Construction Grout by Gifford Hill & Co.; Euco NS by The Euclid Chemical Co.; NBEC Grout by U. S. Grout Corp. or approved equal.
      b. Flowable (Precision) non-shrink cementitious grout shall conform to the standards stated above and shall be Masterflow 928 by Master Builders, Inc.; Hi-Flow Grout by the Euclid Chemical Co.; SikaGrout 212 by Sika Corp.; Supreme Grout by Gifford Hill & Co.; Five Star Grout by U. S. Grout Corp. or approved equal.

B. Non-shrink Epoxy Grout: Non-shrink epoxy-based grout shall be a pre-proportioned, three components, 100 percent solids system consisting of epoxy resin, hardener, and blended aggregate. It shall have a compressive strength of 14,000 psi in 7 days when tested in conformity with ASTM D695 and have a maximum thermal expansion of 30 x 10^{-6} when tested in conformity with ASTM C531. The grout shall be Ceilcote 648 CP by Master Builders Inc.; Five Star Epoxy Grout by U.S. Grout Corp.; Sikadur 42 Grout-Pak by Sika Corp.; High Strength Epoxy Grout by the Euclid Chemical Co. or approved equal.

C. Cement Grout: Cement grouts shall be a mixture of one part Portland cement conforming to ASTM C150, Types I, II, or III and 1 to 2 parts sand conforming to ASTM C33 with sufficient water to place the grout. The water content shall be sufficient to impart workability to the grout but not to the degree that it will allow the grout to flow.

D. Concrete Grout
   1. Concrete grout shall conform to the requirements of Division 03 Section "Cast-in-Place Concrete" except as specified herein. It shall be proportioned with cement, coarse and fine aggregates, water, water reducer and air entraining agent to produce a mix having an average strength of 2900 psi at 28 days, or 2500 psi nominal strength. Coarse aggregate size shall be 3/8 -in maximum. Slump should not exceed 5-in and should be as low as practical yet still retain sufficient workability.

E. Water: Potable water, free from injurious amounts of oil, acid, alkali, organic matter, or other deleterious substances.

PART 3 - EXECUTION

3.1 PREPARATION

A. Grout shall be placed over cured concrete which has attained its full design strength unless otherwise approved by the Engineer.

B. Concrete surfaces to receive grout shall be clean and sound; free of ice, frost, dirt, grease, oil, curing compounds, laitance and paints and free of all loose material or foreign matter which may affect the bond or performance of the grout.

C. Roughen concrete surfaces by chipping, sandblasting, or other mechanical means to ensure bond of the grout to the concrete. Remove loose or broken concrete. Irregular voids or projecting coarse aggregate need not be removed if they are sound, free of laitance and firmly embedded into the parent concrete.
   1. Air compressors used to clean surfaces in contact with grout shall be the oil-less type or equipped with an oil trap in the air line to prevent oil from being blown onto the surface.

D. Remove all loose rust, oil or other deleterious substances from metal embedment or bottom of baseplates prior to the installation of the grout.

E. Concrete surfaces shall be washed clean and then kept moist for at least 24 hours prior to the placement of cementitious or cement grout. Saturation may be achieved by covering the concrete with saturated burlap bags, use of a soaker hose, flooding the surface, or other method acceptable to the Engineer. Upon completion of the 24 hour period, visible water shall be removed from the surface prior to grouting. The use of an adhesive bonding agent in lieu of surface saturation shall only be used when approved by the Engineer for each specific location of grout installation.

F. Epoxy-based grouts do not require the saturation of the concrete substrate. Surfaces in contact with epoxy grout shall be completely dry before grouting.

G. Construct grout forms or other leak proof containment as required. Forms shall be lined or coated with release agents recommended by the grout manufacturer. Forms shall be of adequate strength, securely anchored in place and shored to resist the forces imposed by the grout and its placement.
   1. Forms for epoxy grout shall be designed to allow the formation of a hydraulic head and shall have chamfer strips built into forms.

H. Level and align the structural or equipment bearing plates in accordance with the structural requirements and the recommendations of the equipment manufacturer.

I. Equipment shall be supported during alignment and installation of grout by shims, wedges, blocks or other approved means. The shims, wedges and blocking devices shall be prevented from bonding to the grout by appropriate bond breaking coatings and removed after grouting unless otherwise approved by the Engineer.

3.2 INSTALLATION - GENERAL

A. Mix, apply and cure products in strict compliance with the manufacturer's recommendations and this Section.

B. Have sufficient manpower and equipment available for rapid and continuous mixing and placing. Keep all necessary tools and materials ready and close at hand.

C. Maintain temperatures of the foundation plate, supporting concrete, and grout between 40 and 90 degrees F during grouting and for at least 24 hours thereafter or as recommended by the grout manufacturer, whichever is longer. Take precautions to minimize differential heating or cooling of baseplates and grout during curing period.

D. Take special precautions for hot weather or cold weather grouting as recommended by the manufacturer when ambient temperatures and/or the temperature of the materials in contact with the grout are outside of the 60 and 90 degrees F range.

E. Install grout in a manner which will preserve the isolation between the elements on either side of the joint where grout is placed in the vicinity of an expansion or control joint.

F. Reflect all existing underlying expansion, control and construction joints through the grout.

3.3 INSTALLATION - CEMENT GROUTS AND NONSHRINK CEMENTITIOUS GROUTS

A. Mix in accordance with manufacturer's recommendations. Do not add cement, sand, pea gravel or admixtures without prior approval by the Engineer.

B. Avoid mixing by hand. Mixing in a mortar mixer (with moving blades) is recommended. Pre-wet the mixer and empty excess water. Add pre-measured amount of water for mixing, followed by the grout. Begin with the minimum amount of water recommended by the manufacturer and then add the minimum additional water required to obtain workability. Do not exceed the manufacturer's maximum recommended water content.

C. Placements greater than 3-in in depth shall include the addition of clean, washed pea gravel to the grout mix when approved by the manufacturer. Comply with the manufacturer's recommendations for the size and amount of aggregate to be added.

D. Place grout into the designated areas in a manner which will avoid segregation or entrapment of air. Do not vibrate grout to release air or to consolidate the material. Placement should proceed in a manner which will ensure the filling of all spaces and provide full contact between the grout and adjoining surfaces. Provide grout holes as necessary.

E. Place grout rapidly and continuously to avoid cold joints. Do not place cement grouts in layers. Do not add additional water to the mix (retemper) after initial stiffening.

F. Just before the grout reaches its final set, cut back the grout to the substrate at a 45 degree angle from the lower edge of bearing plate unless otherwise approved by the Engineer. Finish this surface with a wood float (brush) finish.

G. Begin curing immediately after form removal, cutback, and finishing. Keep grout moist and within its recommended placement temperature range for at least 24 hours after placement or longer if recommended by the manufacturer. Saturate the grout surface by use of wet burlap, soaker hoses, ponding or other approved means. Provide sunshades as necessary. If drying winds inhibit the ability of a given curing method to keep grout moist, erect wind breaks until wind is no longer a problem or curing is finished.

3.4 INSTALLATION - NONSHRINK EPOXY GROUTS

A. Mix in accordance with the procedures recommended by the manufacturer. Do not vary the ratio of components or add solvent to change the consistency of the grout mix. Do not over mix. Mix full batches only to maintain proper proportions of resin, hardener and aggregate.

B. Monitor ambient weather conditions and contact the grout manufacturer for special placement procedures to be used for temperatures below 60 or above 90 degrees F.

C. Place grout into the designated areas in a manner which will avoid trapping air. Placement methods shall ensure the filling of all spaces and provide full contact between the grout and adjoining surfaces. Provide grout holes as necessary.

D. Minimize "shoulder" length (extension of grout horizontally beyond base plate). In no case shall the shoulder length of the grout be greater than the grout thickness.

E. Finish grout by puddling to cover all aggregate and provide a smooth finish. Break bubbles and smooth the top surface of the grout in conformity with the manufacturer's recommendations.

F. Epoxy grouts are self curing and do not require the application of water. Maintain the formed grout within its recommended placement temperature range for at least 24 hours after placing, or longer if recommended by the manufacturer.

3.5 INSTALLATION - CONCRETE GROUT

A. Screed underlying concrete to the grade shown on the Drawings. Provide the surface with a broomed finish, aligned to drain. Protect and keep the surface clean until placement of concrete grout.

B. Remove the debris and clean the surface by sweeping and vacuuming of all dirt and other foreign materials. Wash the tank slab using a strong jet of water. Flushing of debris into tank drain lines will not be permitted.

C. Saturate the concrete surface for at least 24 hours prior to placement of the concrete grout. Saturation may be maintained by ponding, by the use or soaker hoses, or by other methods acceptable to the Engineer. Remove excess water just prior to placement of the concrete grout. Place cement slurry immediately ahead of the concrete grout so that the slurry is moist when the grout is placed. Work the slurry over the surface with a broom until it is coated with approximately 1/16 to 1/8-in thick cement paste. [(A bonding grout composed of 1 part Portland cement, 1.5 parts fine sand, an approved bonding admixture and water, mixed to achieve the consistency of thick paint, may be substituted for the cement slurry.)]

D. Place concrete grout to final grade using the scraper mechanism as a guide for surface elevation and to ensure high and low spots are eliminated. Unless specifically approved by the equipment manufacturer, mechanical scraper mechanisms shall not be used as a finishing machine or screed.

E. Provide grout control joints as indicated on the Drawings.

F. Finish and cure the concrete grout as specified for cast-in-place concrete.

3.6 SCHEDULE

A. The following list indicates where the particular types of grout are to be used:
   1. General purpose non-shrink cementitious grout: Use at all locations where non shrink grout is called for on the plans except for base plates greater in area than 3-ft wide by 3-ft long and except for the setting of anchor rods, anchor bolts or reinforcing steel in concrete.

2. Flowable non-shrink cementitious grout: Use under all base plates greater in area than 3-ft by 3-ft. Use at all locations indicated to receive flowable non-shrink grout by the Drawings. The Contractor, at his/her option and convenience, may also substitute flowable non-shrink grout for general purpose non-shrink cementitious grout.
3. Non-shrink epoxy grout: Use for the setting of anchor rods, anchor bolts and reinforcing steel in concrete and for all locations specifically indicated to receive epoxy grout.
4. Cement grout: Cement grout may be used for grouting of incidental base plates for structural and miscellaneous steel such as post base plates for platforms, base plates for beams, etc. It shall not be used when non-shrink grout is specifically called for on the Drawings or for grouting of primary structural steel members such as columns and girders.
5. Concrete grout: Use for overlaying the base concrete under scraper mechanisms of clarifiers to allow more control in placing the surface grade.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes unit masonry assemblies consisting of the following:
1. Concrete masonry units (CMUs).
2. Decorative concrete masonry units.
3. Mortar and grout.
4. Reinforcing steel.
5. Masonry joint reinforcement.
6. Ties and anchors.
7. Embedded flashing.
8. Miscellaneous masonry accessories.
9. Masonry-cell insulation.

B. Related Sections include the following:
1. Division 07 Section "Bituminous Dampproofing" for dampproofing applied to cavity face of backup wythes of cavity walls.
2. Division 07 Section "Joint Sealants" for sealing control and expansion joints in unit masonry.

C. Products installed, but not furnished, under this Section include the following:
1. Steel lintels and shelf angles for unit masonry, furnished under Division 05 Section "Metal Fabrications" and/or “Structural Steel”.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For the following:
1. Masonry Units: Show sizes, profiles, coursing and locations of special shapes.
2. Reinforcing Steel: Detail bending and placement of unit masonry reinforcing bars. Comply with ACI 315, "Details and Detailing of Concrete Reinforcement.
3. Fabricated Flashing: Detail corner units, end-dam units, and other special applications.

C. Samples for Initial Selection: For the following:
1. Decorative concrete masonry units, in the form of small-scale units.
2. Colored mortar.

D. Samples for Verification: For each type and color of the following:
1. Exposed concrete masonry units.
2. Pigmented and colored-aggregate mortar. Make Samples using same sand and mortar ingredients to be used on Project**.** Label Samples to indicate types and amounts of pigments used.
3. Accessories embedded in masonry.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

E. List of Materials Used in Constructing Mockups: List generic product names together with manufacturers, manufacturers' product names, model numbers, lot numbers, batch numbers, source of supply, and other information as required to identify materials used. Include mix proportions for mortar and grout and source of aggregates.
   1. Submittal is for information only. Neither receipt of list nor approval of mockup constitutes approval of deviations from the Contract Documents, unless such deviations are specifically brought to the attention of Architect and approved in writing.

F. Qualification Data: For Testing Agency.

G. Material Certificates: Include statements of material properties indicating compliance with requirements including compliance with standards and type designations within standards. Provide for each type and size of the following:
   1. Masonry units.
      a. Include material test reports substantiating compliance with requirements.
      b. For masonry units used in structural masonry, include data and calculations establishing average net-area compressive strength of units.
   2. Cementitious materials. Include brand, type, and name of manufacturer.
   3. Preblended, dry mortar mixes. Include description of type and proportions of all ingredients.
   4. Reinforcing bars.
   5. Joint reinforcement.
   6. Anchors, ties, and metal accessories.

H. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.
   1. Include test reports, per ASTM C 1019, for grout and mortar mixes required to comply with compressive strength requirement.

I. Cold-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with cold-weather requirements.

J. Hot-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with hot-weather requirements.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency qualified according to ASTM C 1093 for testing indicated, as documented according to ASTM E 548.

B. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, through one source from a single manufacturer for each product required.

C. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from a single manufacturer for each cementitious component and from one source or producer for each aggregate.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

D. Fire-Resistance Ratings: Where indicated, provide materials and construction identical to those of assemblies with fire-resistance ratings determined per ASTM E 119 by a testing and inspecting agency, by equivalent concrete masonry thickness, by U.L. Design indicated, or by other means, as acceptable to authorities having jurisdiction.

E. Sample Panels: Build sample panels to verify selections made under sample submittals and to demonstrate aesthetic effects. Comply with requirements in Division 01 Section "Quality Requirements" for mockups.
   1. Build sample panels for typical exterior and interior walls in sizes approximately 48 inches (1200 mm) long by 48 inches (1200 mm) high by full thickness.
   2. Clean one-half of exposed faces of panels with masonry cleaner indicated.
   3. Protect approved sample panels from the elements with weather-resistant membrane.
   4. Approval of sample panels is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; aesthetic qualities of workmanship; and other material and construction qualities specifically approved by Architect in writing.
      a. Approval of sample panels does not constitute approval of deviations from the Contract Documents contained in sample panels, unless such deviations are specifically approved by Architect in writing.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.

B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

D. Deliver preblended, dry mortar mix in moisture-resistant containers designed for lifting and emptying into dispensing silo. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location or in a metal dispensing silo with weatherproof cover.

E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.6 PROJECT CONDITIONS

A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.
   1. Extend cover a minimum of 24 inches (600 mm) down both sides and hold cover securely in place.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least 3 days after building masonry walls or columns.

C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.
   1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
   2. Protect sills, ledges, and projections from mortar droppings.
   3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
   4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.

D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.
   1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F (4 deg C) and above and will remain so until masonry has dried, but not less than 7 days after completing cleaning.

E. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Products: Subject to compliance with requirements, provide one of the products specified.
   2. Manufacturers: Subject to compliance with requirements, provide products by Westside Masonry, or approved equal, to match existing Sludge Processing Building CMUs.

2.2 MASONRY UNITS, GENERAL

A. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to exceed tolerances and to contain chips, cracks, or other defects exceeding limits stated in the standard. Do not use units where such defects, including dimensions that vary from specified dimensions by more than stated tolerances, will be exposed in the completed Work or will impair the quality of completed masonry.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2.3 CONCRETE MASONRY UNITS (CMUs)

A. Shapes: Provide shapes indicated and as follows:
   1. Provide special shapes for bond beams, lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
   2. Provide square-edged units for outside corners, unless otherwise indicated.

B. Integral Water Repellent: Provide units made with integral water repellent for exposed units and units within exterior wall construction.
   1. Integral Water Repellent: Liquid polymeric, integral water-repellent admixture that does not reduce flexural bond strength. Units made with integral water repellent, when tested as a wall assembly made with mortar containing integral water-repellent manufacturer's mortar additive according to ASTM E 514, with test period extended to 24 hours, show no visible water or leaks on the back of test specimen.
      a. Products:
         1) Addiment Incorporated; Block Plus W-10.
         2) Grace Construction Products, a unit of W. R. Grace & Co. - Conn.; Dry-Block.
         3) Master Builders, Inc.; Rheopel.
         4) Sonneborn, Div. of ChemRex; Hydrocide Powder.
         5) Or approved equal.

C. Concrete Masonry Units: ASTM C 90.
   1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 2150 psi (14.8 MPa).
   2. Weight Classification: Normal weight, unless otherwise indicated.
   3. Size (Width): Manufactured to dimensions 3/8 inch less than nominal dimensions.
   4. Exposed Faces: Provide color and texture matching existing Sludge Processing Building.

D. Decorative Concrete Masonry Units: ASTM C 90.
   1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 2150 psi (14.8 MPa).
   2. Weight Classification: Normal weight.
   3. Size (Width): Manufactured to dimensions specified in "Concrete Masonry Units" Paragraph above.
   4. Pattern and Texture:
      a. Standard pattern, split-face finish; matching existing Sludge Processing Building.
   5. Colors: Match existing Sludge Processing Building.
   6. Products:
      a. Trenwyth Industries, Trenwyth Split-Faced and Treadstone Plus.
      b. Or approved equal.

2.4 CONCRETE AND MASONRY LINTELS

A. General: Provide either concrete or masonry lintels, at Contractor's option, complying with requirements below.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Concrete Lintels: Precast units made from concrete matching concrete masonry units in color, texture, and compressive strength and with reinforcing bars indicated or required to support loads indicated. Cure precast lintels by same method used for concrete masonry units. Comply with requirements in Division 03 Section "Cast-in-Place Concrete."

C. Masonry Lintels: Prefabricated or built-in-place masonry lintels made from bond beam concrete masonry units with reinforcing bars placed as indicated and filled with coarse grout. Cure precast lintels before handling and installing. Temporarily support built-in-place lintels until cured.

2.5 MORTAR AND GROUT MATERIALS

A. Portland Cement: ASTM C 150, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.

B. Hydrated Lime: ASTM C 207, Type S.

C. Portland Cement-Lime Mix: Packaged blend of portland cement complying with ASTM C 150, Type I or Type III, and hydrated lime complying with ASTM C 207, Type S.

D. Masonry Cement: Not permitted.

E. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes. Use only pigments with a record of satisfactory performance in masonry mortar.
   1. Products:
      a. Bayer Corporation, Industrial Chemicals Div.; Bayferrox Iron Oxide Pigments.
      b. Davis Colors; True Tone Mortar Colors.
      c. Solomon Grind-Chem Services, Inc.; SGS Mortar Colors.
      d. Or approved equal.

F. Colored Cement Product: Packaged blend made from portland cement and lime and mortar pigments, all complying with specified requirements, and containing no other ingredients.
   1. Formulate blend as required to produce color indicated or, if not indicated, as selected from manufacturer's standard colors.
   2. Pigments shall not exceed 10 percent of portland cement by weight.
   3. Products:
      a. Colored Portland Cement-Lime Mix:
         1) Capital Materials Corporation; Riverton Portland Cement Lime Custom Color.
         2) Holcim (US) Inc.; Rainbow Mortamix Custom Color Cement/Lime.
         3) Lafarge North America Inc.; Eaglebond.
         4) Lehigh Cement Company; Lehigh Custom Color Portland/Lime Cement.
         5) Or approved equal.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

G. Aggregate for Mortar: ASTM C 144.
   1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
   2. For joints less than 1/4 inch (6.5 mm) thick, use aggregate graded with 100 percent passing the No. 16 (1.18-mm) sieve.

H. Aggregate for Grout: ASTM C 404.

I. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C 494/C 494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.
   1. Products:
      a. Addiment Incorporated; Mortar Kick.
      b. Euclid Chemical Company (The); Accelguard 80.
      c. Grace Construction Products, a unit of W. R. Grace & Co. - Conn.; Morset.
      d. Sonneborn, Div. of ChemRex; Trimix-NCA.
      e. Or approved equal.

J. Water-Repellent Admixture: Liquid water-repellent mortar admixture intended for use with concrete masonry units, containing integral water repellent by same manufacturer.
   1. Products:
      a. Addiment Incorporated; Mortar Tite.
      b. Grace Construction Products, a unit of W. R. Grace & Co. - Conn.; Dry-Block Mortar Admixture.
      c. Master Builders, Inc.; Color Cure Mortar Admix or Rheomix Rheopel.
      d. Sonneborn, Div. of ChemRex; Hydrocide Powder.
      e. Or approved equal.

K. Water: Potable.

2.6 REINFORCEMENT

A. Uncoated Steel Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420).

B. Masonry Joint Reinforcement, General: ASTM A 951.
   1. Interior Walls: Hot-dip galvanized, carbon steel.
   2. Exterior Walls: Hot-dip galvanized, carbon steel.
   3. Wire Size for Side Rods: W1.7 or 0.148-inch (3.8-mm) diameter.
   4. Wire Size for Cross Rods: W1.7 or 0.148-inch (3.8-mm) diameter.
   5. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches (407 mm) o.c.
   6. Provide in lengths of not less than 10 feet (3 m), with prefabricated corner and tee units.

C. Masonry Joint Reinforcement for Single-Wythe Masonry: Ladder or truss type with single pair of side rods.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2.7 TIES AND ANCHORS

A. Materials: Provide ties and anchors specified in subsequent paragraphs that are made from materials that comply with the subparagraphs below, unless otherwise indicated.

B. Wire Ties, General: Unless otherwise indicated, size wire ties to extend at least halfway through veneer but with at least 5/8-inch (16-mm) cover on outside face. Outer ends of wires are bent 90 degrees and extend 2 inches (50 mm) parallel to face of veneer.

C. Adjustable Anchors for Connecting to Structure: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.
   1. Connector Section for Concrete: Dovetail tabs for inserting into dovetail slots in concrete and attached to tie section; formed from 0.053-inch (1.3-mm) thick, steel sheet, galvanized after fabrication.

D. Partition Top anchors: 0.097-inch (2.5-mm-) thick metal plate with 3/8-inch (10-mm-) diameter metal rod 6 inches (150 mm) long welded to plate and with closed-end plastic tube fitted over rod that allows rod to move in and out of tube. Fabricate from steel, hot-dip galvanized after fabrication.

2.8 MISCELLANEOUS ANCHORS

A. Anchor Bolts: Headed steel bolts complying with ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); with ASTM A 563 (ASTM A 563M) hex nuts and, where indicated, flat washers; hot-dip galvanized to comply with ASTM A 153/A 153M, Class C; of dimensions indicated.

2.9 EMBEDDED FLASHING MATERIALS

A. Metal Flashing: Provide metal flashing, where flashing is exposed or partly exposed and where indicated, complying with SMACNA's "Architectural Sheet Metal Manual and as follows:
   1. Stainless Steel: ASTM A 240/A 240M, Type 304, 0.016 inch (0.4 mm) thick.
   2. Copper: ASTM B 370, Temper H00 or H01, cold-rolled copper sheet, 12-oz.sq.ft. (4-kg/sq.m) weight for full concealed flashing; 16-oz./ft. (5-kg/sq.m) weight or 0.0216 inch (0.55 mm) thick elsewhere.
   3. Fabricate continuous flashings in sections 96 inches (2400 mm) long minimum, but not exceeding 12 feet (3.6 m). Provide splice plates at joints of formed, smooth metal flashing.
   4. Fabricate discontinuous lintel, sill and similar flashings to extend 6-inches(150 mm) beyond each side of wall openings. Form 2-inch(50 mm) high end dams.
   5. Fabricate through-wall flashing with snaplock receiver on exterior face where indicated to receive counterflashing.
   6. Fabricate through-wall flashing with drip edge, unless otherwise indicated. Fabricate by extending flashing 1/2 inch (13 mm) out from wall, with outer edge bent down 30 degrees and hemmed.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

7. Metal Drip Edges: Fabricate from stainless steel. Extend at least 3 inches (75 mm) into wall and 1/2 inch (13 mm) out from wall, with outer edge bent down 30 degrees and hemmed.

B. Single-Wythe CMU Flashing System: System of CMU cell flashing pans and interlocking CMU web covers made from high-density polyethylene incorporating chemical stabilizers that prevent UV degradation. Cell flashing pans have integral weep spouts that are designed to be built into mortar bed joints and weep collected moisture to the exterior of CMU walls and that extend into the cell to prevent clogging with mortar.
1. Product: Subject to compliance with requirements, provide "Blok-Flash" by Advanced Building Products Inc. or approved equal.

C. Solder and Sealants for Sheet Metal Flashings:
1. Solder for Stainless Steel: ASTM B 32, Grade Sn60, with acid flux of type recommended by stainless-steel sheet manufacturer.
2. Elastomeric Sealant: ASTM C 920, chemically curing silicone sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.

2.10 MISCELLANEOUS MASONRY ACCESSORIES

A. Compressible Filler: Premolded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene.

B. Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTM D 2000, Designation M2AA-805 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.

C. Bond-Breaker Strips: Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).

D. Weep/Vent Products: Use one of the following, unless otherwise indicated:
1. Cellular Plastic Weep/Vent: One-piece, flexible extrusion made from UV-resistant polypropylene copolymer, full height and width of head joint and depth 1/8 inch (3 mm) less than depth of outer wythe, in color selected from manufacturer's standard.
   a. Products:
      1) Dayton Superior Corporation, Dur-O-Wal Division; Cell Vents.
      2) Heckmann Building Products Inc.; No. 85 Cell Vent.
      3) Hohmann & Barnard, Inc.; Quadro-Vent.
      4) Wire-Bond; Cell Vent.
      5) Or approved equal.
2. Mesh Weep/Vent: Free-draining mesh; made from polyethylene strands, full height and width of head joint and depth 1/8 inch (3 mm) less than depth of outer wythe; in color selected from manufacturer's standard.
   a. Products:
      1) Archovations, Inc.; CavClear Weep Vents.
      2) Mortar Net USA, Ltd.; Mortar Net Weep Vents.
      3) Or approved equal.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

E. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells with loops for holding reinforcing bars in center of cells. Units are formed from 0.142-inch (3.6-mm) steel wire, hot-dip galvanized after fabrication. Provide units with either two loops or four loops as needed for number of bars indicated.
   1. Products:
      a. Dayton Superior Corporation, Dur-O-Wal Division; D/A 810, D/A 812 or D/A 817.
      b. Heckmann Building Products Inc.; No. 376 Rebar Positioner.
      c. Hohmann & Barnard, Inc.; #RB or #RB-Twin Rebar Positioner.
      d. Wire-Bond; O-Ring or Double O-Ring Rebar Positioner.
      e. Or approved equal.

2.11 MASONRY-CELL INSULATION

A. Molded-Polystyrene Insulation Units: Rigid, cellular thermal insulation formed by the expansion of polystyrene-resin bead or granules in a closed mold to comply with ASTM C578, Type 1. Provide specially shaped units designed for installing in cores of masonry units.
   1. Products:
      a. Concrete Block Insulating Systems; Kerfil.
      b. Shelter Enterprises, Inc.; Omni Core.
      c. Or approved equal.

2.12 MASONRY CLEANERS

A. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.
   1. Manufacturers:
      a. Diedrich Technologies, Inc.
      b. EaCo Chem, Inc.
      c. ProSoCo, Inc.
      d. Or approved equal.

2.13 MORTAR AND GROUT MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated.
   1. Do not use calcium chloride in mortar or grout.
   2. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.

B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

C. Mortar for Unit Masonry: Comply with ASTM C 270, Property Specification. Provide the following types of mortar for applications stated unless another type is indicated or needed to provide required compressive strength of masonry.
   1. For masonry below grade or in contact with earth, use Type M.
   2. For reinforced masonry, use Type S.
   3. For mortar parge coats, use Type S or N.
   4. For interior non-load-bearing partitions; and for other applications where another type is not indicated, use Type N.

D. Colored-Aggregate Mortar: Produce required mortar color by using colored aggregates and natural color or white cement as necessary to produce required mortar color.
   1. Mix to match existing Sludge Processing Building.

E. Grout for Unit Masonry: Comply with ASTM C 476.
   1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 1.15.1 in ACI 530.1/ASCE 6/TMS 602 for dimensions of grout spaces and pour height.
   2. Provide grout with a slump of 8 to 11 inches (200 to 280 mm) as measured according to ASTM C 143/C 143M.

2.14 SOURCE QUALITY CONTROL

A. Owner will engage a qualified independent testing agency to perform source quality-control testing indicated below:
   1. Payment for these services will be made by Owner.
   2. Retesting of materials failing to comply with specified requirements shall be done at Contractor's expense.

B. Concrete Masonry Unit Test: For each type of unit furnished, per ASTM C 140.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.
   1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of work.
   2. Verify that foundations are within tolerances specified.
   3. Verify that reinforcing dowels are properly placed.

B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping connections.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3.2 INSTALLATION, GENERAL

A. Thickness: Build cavity and composite walls and other masonry construction to full thickness shown. Build single-wythe walls to actual widths of masonry units, using units of widths indicated.

B. Build chases and recesses to accommodate items specified in this and other Sections.

C. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match the construction immediately adjacent to opening.

D. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

E. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures.
   1. Mix units from several pallets or cubes as they are placed.

F. Comply with construction tolerances in ACI 530.1/ASCE 6/TMS 602 and with the following:
   1. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet (3 mm in 3 m), 1/4 inch in 20 feet (6 mm in 6 m), or 1/2 inch (12 mm) maximum.
   2. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet (6 mm in 3 m), or 1/2 inch (12 mm) maximum.
   3. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet (3 mm in 3 m), 1/4 inch in 20 feet (6 mm in 6 m), or 1/2 inch (12 mm) maximum.
   4. For exposed bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch (3 mm), with a maximum thickness limited to 1/2 inch (12 mm). Do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch (3 mm).
   5. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch (3 mm). Do not vary from adjacent bed-joint and head-joint thicknesses by more than 1/8 inch (3 mm).
   6. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch (1.5 mm) except due to warpage of masonry units within tolerances specified for warpage of units.
   7. For exposed bed joints and head joints of stacked bond, do not vary from a straight line by more than 1/16 inch (1.5 mm) from one masonry unit to the next.

3.3 LAYING MASONRY WALLS

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less than nominal 4-inch (100-mm) horizontal face dimensions at corners or jambs.

C. Stopping and Resuming Work: Stop work by racking back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.

D. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.

E. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below and rod mortar or grout into core.

F. Fill cores in hollow concrete masonry units with grout 24 inches (600 mm) under bearing plates, beams, lintels, posts, and similar items, unless otherwise indicated.

G. Build non-load-bearing interior partitions full height of story to underside of solid floor or roof structure above, unless otherwise indicated.
   1. Install compressible filler in joint between top of partition and underside of structure above, unless otherwise indicated in drawings.
   2. At fire-rated partitions, treat joint between top of partition and underside of structure above to comply with Division 07 Section "Fire-Resistive Joint Systems", unless otherwise indicated in drawings.

3.4 MORTAR BEDDING AND JOINTING

A. Lay hollow concrete masonry units as follows:
   1. With face shells fully bedded in mortar and with head joints of depth equal to bed joints.
   2. With webs fully bedded in mortar in all courses of piers, columns, and pilasters
   3. With webs fully bedded in mortar in grouted masonry, including starting course on footings.
   4. With entire units, including areas under cells, fully bedded in mortar at starting course on footings where cells are not grouted.

B. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

C. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness, unless otherwise indicated.

D. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint), unless otherwise indicated.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3.5 MASONRY-CELL INSULATION

A. Install molded-polystyrene insulation units into masonry unit cells before laying units.

3.6 MASONRY JOINT REINFORCEMENT

A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch (16 mm) on exterior side of walls, 1/2 inch (13 mm) elsewhere. Lap reinforcement a minimum of 8 inches.
   1. Space reinforcement not more than 16 inches (406 mm) o.c.
   2. Space reinforcement not more than 8 inches (203 mm) o.c. in foundation walls and parapet walls.
   3. Provide first layer of reinforcement not more than 8 inches (203 mm) above and below wall openings and extending 12 inches (305 mm) beyond openings.
      a. Reinforcement above is in addition to continuous reinforcement.

B. Interrupt joint reinforcement at control and expansion joints, unless otherwise indicated.

C. Provide continuity at wall intersections by using prefabricated T-shaped units.

D. Cut and bend reinforcing units as directed by manufacturer for continuity at corners, returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

3.7 CONTROL AND EXPANSION JOINTS

A. General: Install control and expansion joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.

B. Form control joints in concrete masonry as follows:
   1. Fit bond-breaker strips into hollow contour in ends of concrete masonry units on one side of control joint. Fill resultant core with grout and rake out joints in exposed faces for application of sealant.

C. Provide horizontal, pressure-relieving joints by either leaving an air space or inserting a compressible filler of width required for installing sealant and backer rod specified in Division 07 Section "Joint Sealants," but not less than 3/8 inch (10 mm).
   1. Locate horizontal, pressure-relieving joints beneath shelf angles supporting masonry.

3.8 LINTELS

A. Provide concrete or masonry lintels where shown and where openings of more than 12 inches (305 mm) for brick-size units and 24 inches (610 mm) for block-size units are shown without structural steel or other supporting lintels.

B. Provide minimum bearing of 8 inches (200 mm) at each jamb, unless otherwise indicated.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3.9 FLASHING, WEEP HOLES, CAVITY DRAINAGE, AND VENTS

A. General: Install embedded flashing and weep/vent holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated.

B. Install flashing as follows, unless otherwise indicated:
   1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer.
   2. At lintels and shelf angles, extend flashing a minimum of 6 inches (150 mm) into masonry at each end. At heads and sills, extend flashing 6 inches (150 mm) at ends and turn up not less than 2 inches (50 mm) to form end dams.

C. Install single-wythe CMU flashing system in bed joints of CMU walls where indicated to comply with manufacturer's written instructions. Install CMU cell pans with upturned edges located below face shells and webs of CMUs above and with weep spouts aligned with face of wall. Install CMU web covers so that they cover upturned edges of CMU cell pans at CMU webs and extend from face shell to face shell.

D. Install reglets and nailers for flashing and other related construction where they are shown to be built into masonry.

E. Install weep holes in head joints in exterior wythes of first course of masonry immediately above embedded flashing, and as follows:
   1. Use specified weep/vent products to form weep holes.
   2. Space weep holes 24 inches (600 mm) o.c., unless otherwise indicated.
   3. Cover cavity side of weep holes with plastic insect screening at cavities insulated with loose-fill insulation.

F. Place cavity drainage material in cavities to comply with configuration requirements for cavity drainage material in Part 2 "Miscellaneous Masonry Accessories" Article.

3.10 REINFORCED UNIT MASONRY INSTALLATION

A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.
   1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
   2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other temporary loads that may be placed on them during construction, but no less than two weeks.

B. Placing Reinforcement: Comply with requirements in ACI 530.1/ASCE 6/TMS 602.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.
   1. Comply with requirements in ACI 530.1/ASCE 6/TMS 602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
   2. Limit height of vertical grout pours to not more than 48 inches for cells containing #3 through #6 bars and 60 inches for #7 and larger bars.

3.11 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections indicated below and prepare test reports:
   1. Place grout only after inspectors have verified compliance of grout spaces and grades, sizes, and locations of reinforcement.
   2. Payment for these services will be made by Owner.
   3. Retesting of materials failing to comply with specified requirements shall be done at Contractor's expense.

B. Testing Frequency: One set of tests for each 5000 sq. ft. (465 sq. m) of wall area or portion thereof.

C. Concrete Masonry Unit Test: For each type of unit provided, per ASTM C 140.

3.12 PARGING

A. Parge exterior faces of below-grade masonry walls, where indicated, in 2 uniform coats to a total thickness of 3/4 inch (19 mm). Dampen wall before applying first coat and scarify first coat to ensure full bond to subsequent coat.

B. Use a steel-trowel finish to produce a smooth, flat, dense surface with a maximum surface variation of 1/8 inch per foot (3 mm per 300 mm). Form a wash at top of parging and a cove at bottom.

C. Damp-cure parging for at least 24 hours and protect parging until cured.

3.13 REPAIRING, POINTING, AND CLEANING

A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.

B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.

C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
   1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
   2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.
   3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
   4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
   5. Clean masonry with a proprietary acidic cleaner applied according to manufacturer's written instructions.

3.14 MASONRY WASTE DISPOSAL

A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.

B. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.
   1. Crush masonry waste to less than 4 inches (100 mm) in each dimension.
   2. Mix masonry waste with at least two parts of specified fill material for each part of masonry waste. Fill material is specified in Division 02 Section "Earthwork."
   3. Do not dispose of masonry waste as fill within 18 inches (450 mm) of finished grade.

C. Excess Masonry Waste: Remove excess, clean masonry waste that cannot be used as fill, as described above, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Miscellaneous steel framing and supports not shown on the Structural Drawings.
   2. Metal bollards.

B. Products furnished, but not installed, under this Section:
   1. Loose steel lintels.

C. Related Sections:
   1. Division 04 Section "Unit Masonry" for installing loose lintels, anchor bolts, and other items built into unit masonry.

1.3 SUBMITTALS

A. Shop Drawings: Show fabrication and installation details for metal fabrication.
   1. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.

1.4 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:
   1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."

PART 2 - PRODUCTS

2.1 METALS, GENERAL

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

2.2 FERROUS METALS

A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

B. Steel Tubing: ASTM A 500, cold-formed steel tubing.

C. Steel Pipe: ASTM A 53/A 53M, standard weight (Schedule 40) unless otherwise indicated.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2.3 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

B. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer compatible with specified topcoat.

C. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

D. Concrete: Comply with requirements in Division 03 Section "Cast-in-Place Concrete" for normal-weight, air-entrained, concrete with a minimum 28-day compressive strength of 3000 psi (20 MPa).

2.4 FABRICATION, GENERAL

A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

D. Form exposed work with accurate angles and surfaces and straight edges.

E. Weld corners and seams continuously to comply with the following:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.

G. Fabricate seams and other connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2.5 METAL BOLLARDS

A. Fabricate metal bollards from Schedule 80 steel pipe.
   1. Where bollards are indicated to receive controls for door operators, provide necessary cutouts for controls and holes for wire.

B. Fabricate bollards with 3/8-inch (9.5-mm) thick steel baseplates for bolting to concrete slab. Drill baseplates at all four corners for 3/4-inch (19-mm) anchor bolts.
   1. Where bollards are to be anchored to sloping concrete slabs, angle baseplates for plumb alignment of bollards.

2.6 LOOSE STEEL LINTELS

A. Fabricate loose steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated. Fabricate in single lengths for each opening unless otherwise indicated. Weld adjoining members together to form a single unit where indicated.

B. Size loose lintels to provide bearing length at each side of openings equal to 1/12 of clear span but not less than 8 inches (200 mm) unless otherwise indicated.

C. Galvanize loose steel lintels located in exterior walls.

2.7 STEEL AND IRON FINISHES

A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/ A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.
   1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.

B. Shop prime iron and steel items not indicated to be galvanized unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, unless otherwise indicated.
   1. Shop prime with universal shop primer.

C. Preparation for Shop Priming: Prepare surfaces to comply with requirements indicated below:
   1. Exterior Items: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
   2. Other Items: SSPC-SP 3, "Power Tool Cleaning."

D. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.
   1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

C. Field Welding: Comply with the following requirements:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.

E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

3.2 INSTALLING METAL BOLLARDS

A. Anchor bollards to existing construction with expansion anchors. Provide four 3/4-inch (19-mm) bolts at each bollard, unless otherwise indicated.
   1. Embed anchor bolts at least 4 inches (100 mm) in concrete.

B. Fill bollards solidly with concrete, mounding top surface to shed water.

3.3 ADJUSTING AND CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
   1. Apply by brush or spray to provide a minimum 2.0-mil (0.05-mm) dry film thickness.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Aluminum tube railings.

1.3 PERFORMANCE REQUIREMENTS

A. General: In engineering railings to withstand structural loads indicated, determine allowable design working stresses of railing materials based on the following:
   1. Aluminum: The lesser of minimum yield strength divided by 1.65 or minimum ultimate tensile strength divided by 1.95.

B. Structural Performance: Railings shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
   1. Handrails and Top Rails of Guards:
      a. Uniform load of 50 lbf/ ft. (0.73 kN/m) applied in any direction.
      b. Concentrated load of 200 lbf (0.89 kN) applied in any direction.
      c. Uniform and concentrated loads need not be assumed to act concurrently.
   2. Infill of Guards:
      a. Concentrated load of 50 lbf (0.22 kN) applied horizontally on an area of 1 sq. ft. (0.093 sq. m).
      b. Infill load and other loads need not be assumed to act concurrently.

C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.
   1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

D. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

1.4 SUBMITTALS

A. Product Data: For the following:
   1. Manufacturer's product lines of mechanically connected railings.
   2. Railing brackets.
   3. Grout, anchoring cement, and paint products.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

C. Samples for Initial Selection: For products involving selection of color, texture, or design.

D. Samples for Verification: For each type of exposed finish required.
   1. Sections of each distinctly different linear railing member, including handrails, top rails, posts, and balusters.
   2. Fittings and brackets.
   3. Assembled Sample of railing system, made from full-size components, including top rail, post, handrail, and infill. Sample need not be full height.
      a. Show method of connecting members at intersections.

E. Welding certificates.

F. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers certifying that shop primers are compatible with topcoats.

G. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, according to ASTM E 894 and ASTM E 935.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of railing from single source from single manufacturer.

B. Welding Qualifications: Qualify procedures and personnel according to the following:
   1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
   2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
   3. AWS D1.6, "Structural Welding Code - Stainless Steel."

1.6 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.

1.7 COORDINATION AND SCHEDULING

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorages for railings. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

C. Schedule installation so wall attachments are made only to completed walls. Do not support railings temporarily by any means that do not satisfy structural performance requirements.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following :
   1. Aluminum Tube Railings:
      a. ATR Technologies, Inc.
      b. Blum, Julius & Co., Inc.
      c. Braun, J. G., Company; a division of the Wagner Companies.
      d. Moultrie Manufacturing Company.
      e. Pisor Industries, Inc.
      f. Superior Aluminum Products, Inc.
      g. Thompson Fabricating, LLC.
      h. Tubular Specialties Manufacturing, Inc.
      i. Wagner, R & B, Inc.; a division of the Wagner Companies.
      j. Or approved equal.

2.2 METALS, GENERAL

A. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.

B. Brackets, Flanges, and Anchors: Cast or formed metal of same type of material and finish as supported rails, unless otherwise indicated.

2.3 ALUMINUM

A. Aluminum, General: Provide alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than the strength and durability properties of alloy and temper designated below for each aluminum form required.

B. Extruded Bars and Tubing: ASTM B 221 (ASTM B 221M), Alloy 6063-T5/T52.

C. Extruded Structural Round Tubing: ASTM B 429/B 429M, Alloy 6063-T6.
   1. Provide Standard Weight (Schedule 40) pipe, unless otherwise indicated.

D. Drawn Seamless Tubing: ASTM B 210 (ASTM B 210M), Alloy 6063-T832.

E. Plate and Sheet: ASTM B 209 (ASTM B 209M), Alloy 6061-T6.

F. Die and Hand Forgings: ASTM B 247 (ASTM B 247M), Alloy 6061-T6.

G. Castings: ASTM B 26/B 26M, Alloy A356.0-T6.

2.4 FASTENERS

A. General: Provide the following:

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1. Ungalvanized-Steel Railings: Plated steel fasteners complying with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5 for zinc coating.

B. Fasteners for Anchoring Railings to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction indicated and capable of withstanding design loads.

C. Fasteners for Interconnecting Railing Components:
1. Provide concealed fasteners for interconnecting railing components and for attaching them to other work, unless otherwise indicated.

D. Post-Installed Anchors: Torque-controlled expansion anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488 conducted by a qualified independent testing agency.
1. Material for Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5, unless otherwise indicated.
2. Material for Exterior Locations and Where Stainless Steel is Indicated: Alloy Group 1 (A1) stainless-steel bolts, ASTM F 593 (ASTM F 738M), and nuts, ASTM F 594 (ASTM F 836M).

2.5 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
1. For aluminum railings, provide type and alloy as recommended by producer of metal to be welded and as required for color match, strength, and compatibility in fabricated items.

B. Etching Cleaner for Galvanized Metal.

C. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

D. Shop Primers: Provide primers that comply with Division 09 painting Sections.

E. Intermediate Coats and Topcoats: Provide products that comply with Division 09 painting Sections.

F. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

G. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

H. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1. Water-Resistant Product: At exterior locations and where indicated provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended by manufacturer for exterior use.

2.6 FABRICATION

A. General: Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage, but not less than that required to support structural loads.

B. Assemble railings in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.

C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

D. Form work true to line and level with accurate angles and surfaces.

E. Fabricate connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

F. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.

G. Connections: Fabricate railings with welded connections unless otherwise indicated.

H. Welded Connections: Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove flux immediately.
   4. At exposed connections, finish exposed surfaces smooth and blended so no roughness shows after finishing and welded surface matches contours of adjoining surfaces.

I. Welded Connections for Aluminum Tube: Fabricate railings to interconnect members with concealed internal welds that eliminate surface grinding, using manufacturer's standard system of sleeve and socket fittings.

J. Nonwelded Connections: Connect members with concealed mechanical fasteners and fittings. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.
   1. Fabricate splice joints for field connection using an epoxy structural adhesive if this is manufacturer's standard splicing method.

K. Form changes in direction as follows:
   1. As detailed.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

L. Bend members in jigs to produce uniform curvature for each configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.

M. Close exposed ends of railing members with prefabricated end fittings.

N. Provide wall returns at ends of wall-mounted handrails, unless otherwise indicated. Close ends of returns unless clearance between end of rail and wall is 1/4 inch (6 mm) or less.

O. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work unless otherwise indicated.

P. Provide inserts and other anchorage devices for connecting railings to concrete or masonry work. Fabricate anchorage devices capable of withstanding loads imposed by railings. Coordinate anchorage devices with supporting structure.

Q. For railing posts set in concrete, provide aluminum or stainless steel sleeves not less than 6 inches (150 mm) long with inside dimensions not less than 1/2 inch (13 mm) greater than outside dimensions of post, with plate forming bottom closure.

R. For removable railing posts, fabricate slip-fit sockets from stainless-steel tube or pipe whose ID is sized for a close fit with posts; limit movement of post without lateral load, measured at top, to not more than one-fortieth of post height. Provide socket covers designed and fabricated to resist being dislodged.
   1. Provide chain with eye, snap hook, and staple across gaps formed by removable railing sections at locations indicated. Fabricate from same metal as railings.

2.7 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.8 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class 1, 0.018 mm or thicker.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Fit exposed connections together to form tight, hairline joints.

B. Perform cutting, drilling, and fitting required for installing railings. Set railings accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.
   1. Do not weld, cut, or abrade surfaces of railing components that have been coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
   2. Set posts plumb within a tolerance of 1/16 inch in 3 feet (2 mm in 1 m).
   3. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet (5 mm in 3 m).

C. Corrosion Protection: Coat concealed surfaces of aluminum that will be in contact with grout, concrete, masonry, wood, or dissimilar metals with a heavy coat of bituminous paint.

D. Adjust railings before anchoring to ensure matching alignment at abutting joints.

E. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

3.2 RAILING CONNECTIONS

A. Nonwelded Connections: Use mechanical joints for permanently connecting railing components. Use wood blocks and padding to prevent damage to railing members and fittings.

B. Welded Connections: Use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections in "Fabrication" Article whether welding is performed in the shop or in the field.

C. Expansion Joints: Install expansion joints at locations indicated but not farther apart than required to accommodate thermal movement. Provide slip-joint internal sleeve extending 2 inches (50 mm) beyond joint on either side, fasten internal sleeve securely to one side, and locate joint within 6 inches (150 mm) of post.

3.3 ATTACHING RAILINGS

A. Attach railings to wall with wall brackets. Provide brackets with 1-1/2-inch (38-mm) clearance from inside face of handrail and finished wall surface. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.
   1. Use type of bracket with predrilled hole for exposed bolt anchorage.
   2. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Secure wall brackets to building construction as follows:
   1. For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.
   2. For hollow masonry anchorage, use toggle bolts.

3.4 ADJUSTING AND CLEANING

A. Clean aluminum by washing thoroughly with clean water and soap and rinsing with clean water.

B. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
   1. Apply by brush or spray to provide a minimum 2.0-mil (0.05-mm) dry film thickness.

C. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

3.5 PROTECTION

A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Substantial Completion.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Cold-applied, cut-back asphalt dampproofing.
   2. Cold-applied, emulsified-asphalt dampproofing.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include recommendations for method of application, primer, number of coats, coverage or thickness, and protection course.

B. Material Certificates: For each product, signed by manufacturers.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain primary dampproofing materials and primers through one source from a single manufacturer. Provide secondary materials recommended by manufacturer of primary materials.

1.5 PROJECT CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit dampproofing to be performed according to manufacturers' written instructions.

PART 2 - PRODUCTS

2.1 COLD-APPLIED, CUT-BACK ASPHALT DAMPPROOFING

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following; or approved equal.
   1. ChemMasters Corp.
   2. Degussa Building Systems; Sonneborn Brand Products.
   3. Gardner Gibson, Inc.
   4. Henry Company.
   5. Karnak Corporation.
   6. Koppers Inc.
   7. Malarkey Roofing Products.
   8. Meadows, W. R., Inc.
   9. Tamms Industries, Inc.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Trowel Coats: ASTM D 4586, Type I, Class 1, fibered.

C. Brush and Spray Coats: ASTM D 4479, Type I, fibered.

D. VOC Content: 250 g/L or less.

2.2 COLD-APPLIED, EMULSIFIED-ASPHALT DAMPPROOFING

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following; or approved equal.
1. ChemMasters Corp.
2. Degussa Building Systems; Sonneborn Brand Products.
3. Gardner Gibson, Inc.
4. Henry Company.
5. Karnak Corporation.
6. Koppers Inc.
7. Malarkey Roofing Products.
8. Meadows, W. R., Inc.
9. Tamms Industries, Inc.

B. Trowel Coats: ASTM D 1227, Type II, Class 1.

C. Fibered Brush and Spray Coats: ASTM D 1227, Type II, Class 1.

D. Brush and Spray Coats: ASTM D 1227, Type III, Class 1.

E. VOC Content: 0.25 lb/gal. (30 g/L) or less.

2.3 PROTECTION COURSE

A. Protection Course, Asphalt-Board Type: ASTM D 6506, premolded, 1/8-inch- (3-mm-) thick, multi-ply, semirigid board consisting of a mineral-stabilized asphalt core sandwiched between layers of asphalt-saturated felt, and faced on 1 side with polyethylene film.

2.4 MISCELLANEOUS MATERIALS

A. Cut-Back Asphalt Primer: ASTM D 41.

B. Emulsified-Asphalt Primer: ASTM D 1227, Type III, Class 1, except diluted with water as recommended by manufacturer.

C. Asphalt-Coated Glass Fabric: ASTM D 1668, Type I.

D. Patching Compound: Manufacturer's fibered mastic of type recommended by dampproofing manufacturer.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."
   1. When substrates to receive dampproofing are ready, or expected to be ready for application, convene appropriate representatives including the General Contractor, Applicator, Owner and Architect at the project site for the purpose of reviewing requirements and procedures of the application.

B. Examine substrates, with Installer present, for compliance with requirements for surface smoothness and other conditions affecting performance of work.
   1. Proceed with dampproofing application only after substrate construction and penetrating work have been completed and unsatisfactory conditions have been corrected.
   2. Test for surface moisture according to ASTM D 4263.
   3. Acceptance of the substrate by the Applicator should be documented by the Contractor and minutes of the meeting recorded.

3.2 PREPARATION

A. Protection of Other Work: Mask or otherwise protect adjoining exposed surfaces from being stained, spotted, or coated with dampproofing. Prevent dampproofing materials from entering and clogging weep holes and drains.

B. Clean substrates of projections and substances detrimental to work; fill voids, seal joints, and apply bond breakers if any, as recommended by prime material manufacturer.

C. Apply patching compound for filling and patching tie holes, honeycombs, reveals, and other imperfections; cover with asphalt-coated glass fabric.

3.3 APPLICATION, GENERAL

A. Comply with manufacturer's written recommendations unless more stringent requirements are indicated or required by Project conditions to ensure satisfactory performance of dampproofing.
   1. Apply additional coats if recommended by manufacturer or if required to achieve coverages indicated.
   2. Allow each coat of dampproofing to cure 24 hours before applying subsequent coats.
   3. Allow 36 hours drying time prior to backfilling.

B. Apply dampproofing to footings and foundation walls where opposite side of wall faces building interior.
   1. Apply from finished-grade line to top of footing, extend over top of footing, and down a minimum of 6 inches (150 mm) over outside face of footing.
   2. Extend 12 inches (300 mm) onto intersecting walls and footings, but do not extend onto surfaces exposed to view when Project is completed.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3. Where material is extended onto adjacent surfaces provide straight clean termination by masking or other means.
4. Install flashings and corner protection stripping at internal and external corners, changes in plane, construction joints, cracks, and where shown as "reinforced," by embedding an 8-inch (200-mm) wide strip of asphalt-coated glass fabric in a heavy coat of dampproofing. Dampproofing coat for embedding fabric is in addition to other coats required.

C. Apply dampproofing to provide continuous plane of protection on exterior face of inner wythe of exterior masonry cavity walls.
1. Lap dampproofing at least 1/4 inch (6 mm) onto flashing, masonry reinforcement, veneer ties, and other items that penetrate inner wythe.
2. Where ties are installed after dampproofing activities recoat disturbed and damaged areas with sufficient amount of material to prevent moisture penetration.
3. Extend dampproofing over outer face of structural members and concrete slabs that interrupt inner wythe, and lap dampproofing at least 1/4 inch (6 mm) onto shelf angles supporting veneer.

3.4 COLD-APPLIED, CUT-BACK ASPHALT DAMPPROOFING

A. On Concrete Foundations: Apply 2 brush or spray coats at not less than 1.25 gal./100 sq. ft. (0.5 L/sq. m) for first coat and 1 gal./100 sq. ft. (0.4 L/sq. m) for second coat, or 1 trowel coat at not less than 4 gal./100 sq. ft. (1.6 L/sq. m).

B. On Unexposed Face of Concrete Retaining Walls: Apply 1 brush or spray coat at not less than 1.25 gal./100 sq. ft. (0.5 L/sq. m).

3.5 COLD-APPLIED, EMULSIFIED-ASPHALT DAMPPROOFING

A. On Concrete Foundations: Apply 2 brush or spray coats at not less than 1.5 gal./100 sq. ft. (0.6 L/sq. m) for first coat and 1 gal./100 sq. ft. (0.4 L/sq. m) for second coat, 1 fibered brush or spray coat at not less than 3 gal./100 sq. ft. (1.2 L/sq. m), or 1 trowel coat at not less than 4 gal./100 sq. ft. (1.6 L/sq. m).

B. On Unexposed Face of Concrete Retaining Walls: Apply 1 brush or spray coat at not less than 1.25 gal./100 sq. ft. (0.5 L/sq. m).

3.6 INSTALLATION OF PROTECTION COURSE

A. Install protection course on same day of installation of dampproofing (while coating is tacky) to ensure adhesion.

3.7 CLEANING

A. Remove dampproofing materials from surfaces not intended to receive dampproofing.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Adhered TPO membrane roofing system.
   2. Roof insulation.

B. Related Sections:
   1. Division 07 Section "Joint Sealants" for joint sealants, joint fillers, and joint preparation.

1.3 DEFINITIONS

A. TPO: Thermoplastic polyolefin.

B. Roofing Terminology: See ASTM D 1079 and glossary in NRCA's "The NRCA Roofing and Waterproofing Manual" for definitions of terms related to roofing work in this Section.

1.4 PERFORMANCE REQUIREMENTS

A. General Performance: Installed membrane roofing and base flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Membrane roofing and base flashings shall remain watertight.

B. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by membrane roofing manufacturer based on testing and field experience.

C. Roofing System Design: Provide membrane roofing system that is identical to systems that have been successfully tested by a qualified testing and inspecting agency to resist uplift pressure calculated according to ASCE/SEI 7.
   1. Corner Uplift Pressure: Varies, see Structural Drawings.
   2. Perimeter Uplift Pressure: Varies, see Structural Drawings.

D. Field-of-Roof Uplift Pressure: Varies, see Structural Drawings.FM Approvals Listing: Provide membrane roofing, base flashings, and component materials that comply with requirements in FM Approvals 4450 and FM Approvals 4470 as part of a membrane roofing system, and that are listed in FM Approvals' "RoofNav" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approvals markings.
   1. Fire/Windstorm Classification: Class 1A-90.
   2. Hail Resistance: MH.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For roofing system. Include plans, elevations, sections, details, and attachments to other work.
   1. Base flashings and membrane terminations.
   2. Tapered insulation, including slopes.
   3. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.

C. Samples for Verification: For the following products:
   1. Sheet roofing, of color specified, including T-shaped side and end lap seam.
   2. Roof insulation.
   3. Walkway pads or rolls.
   4. Metal termination bars.
   5. Battens.
   6. Six insulation fasteners of each type, length, and finish.
   7. Six roof cover fasteners of each type, length, and finish.

D. Qualification Data: For qualified Installer and manufacturer.

E. Manufacturer Certificates: Signed by roofing manufacturer certifying that roofing system complies with requirements specified in "Performance Requirements" Article.
   1. Submit evidence of compliance with performance requirements.

F. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for components of membrane roofing system.

G. Research/Evaluation Reports: For components of membrane roofing system, from the ICC-ES.

H. Maintenance Data: For roofing system to include in maintenance manuals.

I. Warranties: Sample of special warranties.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that is UL listed for membrane roofing system identical to that used for this Project.

B. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by membrane roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.

C. Source Limitations: Obtain components including roof insulation and fasteners for membrane roofing system from same manufacturer as membrane roofing or approved by membrane roofing manufacturer.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.

B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.
   1. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.

C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.

D. Handle and store roofing materials and place equipment in a manner to avoid permanent deflection of deck.

1.8 PROJECT CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard or customized form, without monetary limitation, in which manufacturer agrees to repair or replace components of membrane roofing system that fail in materials or workmanship within specified warranty period.
   1. Special warranty includes membrane roofing, base flashings, roof insulation, fasteners, roofing accessories, walkway products, and other components of membrane roofing system.
   2. Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 TPO MEMBRANE ROOFING

A. Fabric-Reinforced Thermoplastic Polyolefin Sheet: ASTM D 6878, internally fabric or scrim reinforced, uniform, flexible fabric backed TPO sheet.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following; or approved equal.
      a. Carlisle SynTec Incorporated.
      b. GAF Materials Corporation.
      c. GenFlex Roofing Systems.
      d. Firestone Building Products.
   2. Thickness: 60 mils (1.5 mm), nominal.
   3. Exposed Face Color: White.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2.2 AUXILIARY MEMBRANE ROOFING MATERIALS

A. General: Auxiliary membrane roofing materials recommended by roofing system manufacturer for intended use, and compatible with membrane roofing.
   1. Liquid-type auxiliary materials shall comply with VOC limits of authorities having jurisdiction.

B. Sheet Flashing: Manufacturer's standard unreinforced thermoplastic polyolefin sheet flashing, 0.45 mils thick, minimum, of same color as sheet membrane.

C. Bonding Adhesive: Manufacturer's standard.

D. Slip Sheet: Manufacturer's standard, of thickness required for application.

E. Metal Termination Bars: Manufacturer's standard, predrilled stainless-steel or aluminum bars, approximately 1 by 1/8 inch (25 by 3 mm) thick; with anchors.

F. Metal Battens: Manufacturer's standard, aluminum-zinc-alloy-coated or zinc-coated steel sheet, approximately 1 inch wide by 0.05 inch thick (25 mm wide by 1.3 mm thick), prepunched.

G. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening membrane to substrate, and acceptable to membrane roofing system manufacturer.

H. Miscellaneous Accessories: Provide pourable sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, T-joint covers, lap sealants, termination reglets, and other accessories.

2.3 ROOF INSULATION

A. Polyisocyanurate Board Insulation: ASTM C 1289, Type II, Class 1, Grade 2, felt or glass-fiber mat facer on both major surfaces.

B. Tapered Insulation: Provide factory-tapered insulation boards fabricated to slope of 1/4 inch per 12 inches (1:48) unless otherwise indicated.

C. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.

D. Roof insulation shall have a minimum R-value of 25.

2.4 INSULATION ACCESSORIES

A. General: Furnish roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with membrane roofing.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation to substrate, and acceptable to roofing system manufacturer.

2.5 WALKWAYS

A. Flexible Walkways: Factory-formed, nonporous, heavy-duty, slip-resisting, surface-textured walkway pads or rolls, approximately 3/16 inch (5 mm) thick, and acceptable to membrane roofing system manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with the following requirements and other conditions affecting performance of roofing system:
1. Verify that roof openings and penetrations are in place and curbs are set and braced and that roof drain bodies are securely clamped in place.
2. Verify that wood blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
3. Verify that surface plane flatness and fastening of steel roof deck complies with requirements in Division 05 Section "Steel Decking."
4. Verify that minimum concrete drying period recommended by roofing system manufacturer has passed.
5. Verify that concrete substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263.
6. Verify that concrete curing compounds that will impair adhesion of roofing components to roof deck have been removed.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing system manufacturer's written instructions. Remove sharp projections.

B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.

C. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at the end of the workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.

3.3 INSULATION INSTALLATION

A. Coordinate installing membrane roofing system components so insulation is not exposed to precipitation or left exposed at the end of the workday.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Comply with membrane roofing system and insulation manufacturer's written instructions for installing roof insulation.

C. Install tapered insulation under area of roofing to conform to slopes indicated.

D. Install insulation under area of roofing to achieve required thickness. Where overall insulation thickness is 2.7 inches (68 mm) or greater, install two or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 6 inches (150 mm) in each direction.

E. Trim surface of insulation where necessary at roof drains so completed surface is flush and does not restrict flow of water.

F. Install insulation with long joints of insulation in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards. Fill gaps exceeding 1/4 inch (6 mm) with insulation.
   1. Cut and fit insulation within 1/4 inch (6 mm) of nailers, projections, and penetrations.

G. Adhered Insulation: Install each layer of insulation and adhere to substrate as follows:
   1. Prime surface of concrete deck with asphalt primer at rate of 3/4 gal./100 sq.ft. (0.3 L/sq.m.) and allow primer to dry.
   2. Set each layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

3.4 ADHERED MEMBRANE ROOFING INSTALLATION

A. Adhere membrane roofing over area to receive roofing and install according to membrane roofing system manufacturer's written instructions.

B. Start installation of membrane roofing in presence of membrane roofing system manufacturer's technical personnel.

C. Accurately align membrane roofing and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.

D. Bonding Adhesive: Apply to substrate and underside of membrane roofing at rate required by manufacturer and allow to partially dry before installing membrane roofing. Do not apply to splice area of membrane roofing.

E. In addition to adhering, mechanically fasten membrane roofing securely at terminations, penetrations, and perimeter of roofing.

F. Apply membrane roofing with side laps shingled with slope of roof deck where possible.

G. Seams: Clean seam areas, overlap membrane roofing, and hot-air weld side and end laps of membrane roofing and sheet flashings according to manufacturer's written instructions to ensure a watertight seam installation.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1. Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of sheet membrane.
2. Verify field strength of seams a minimum of twice daily and repair seam sample areas.
3. Repair tears, voids, and lapped seams in roofing that does not comply with requirements.

H. Spread sealant bed over deck drain flange at roof drains and securely seal membrane roofing in place with clamping ring.

I. Install membrane roofing and auxiliary materials to tie in to existing roofing to maintain weathertightness of transition and to not void warranty for existing membrane roofing system.

3.5 BASE FLASHING INSTALLATION

A. Install sheet flashings and preformed flashing accessories and adhere to substrates according to membrane roofing system manufacturer's written instructions.

B. Apply bonding adhesive to substrate and underside of sheet flashing at required rate and allow to partially dry. Do not apply to seam area of flashing.

C. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.

D. Clean seam areas, overlap, and firmly roll sheet flashings into the adhesive. Hot-air weld side and end laps to ensure a watertight seam installation.

E. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars.

3.6 WALKWAY INSTALLATION

A. Flexible Walkways: Install walkway products in locations indicated. Heat weld to substrate or adhere walkway products to substrate with compatible adhesive according to roofing system manufacturer's written instructions.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion.

C. Repair or remove and replace components of membrane roofing system where inspections indicate that they do not comply with specified requirements.

D. Additional inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3.8 PROTECTING AND CLEANING

A. Protect membrane roofing system from damage and wear during remainder of construction period. When remaining construction will not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner.

B. Correct deficiencies in or remove membrane roofing system that does not comply with requirements; repair substrates; and repair or reinstall membrane roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Copings.
   2. Roof-edge drainage systems.
   3. Reglets and counterflashings.

B. Related Sections:
   1. Division 07 Section "Joint Sealants" for field-applied sealants between roof specialties and adjacent materials.

1.3 PERFORMANCE REQUIREMENTS

A. General Performance: Roof specialties shall withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.

B. FM Approvals' Listing: Manufacture and install copings that are listed in FM Approvals' "RoofNav" and approved for windstorm classification, Class 1-90. Identify materials with FM Approvals' markings.

C. SPRI Wind Design Standard: Manufacture and install copings tested according to SPRI ES-1 and capable of resisting the following design pressures:
   1. Design Pressure: As indicated on Drawings.

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, hole elongation, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Provide clips that resist rotation and avoid shear stress as a result of thermal movements. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
   1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Shop Drawings: For roof specialties. Include plans, elevations, keyed details, and attachments to other work. Distinguish between plant- and field-assembled work. Include the following:
   1. Details for expansion and contraction; locations of expansion joints, including direction of expansion and contraction.
   2. Pattern of seams and layout of fasteners, cleats, clips, and other attachments.
   3. Details of termination points and assemblies, including fixed points.
   4. Details of special conditions.

C. Samples for Initial Selection: For each type of roof specialty indicated with factory-applied color finishes.

D. Samples for Verification: For copings, roof-edge drainage systems, and reglets and counterflashings made from 12-inch (300-mm) lengths of full-size components including fasteners, cover joints, accessories, and attachments.

E. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for copings.

F. Maintenance Data: For roofing specialties to include in maintenance manuals.

G. Warranty: Sample of special warranty.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Do not store roof specialties in contact with other materials that might cause staining, denting, or other surface damage. Store roof specialties away from uncured concrete and masonry.

B. Protect strippable protective covering on roof specialties from exposure to sunlight and high humidity, except to extent necessary for the period of roof specialties installation.

1.6 WARRANTY

A. Special Warranty on Painted Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace roof specialties that show evidence of deterioration of factory-applied finishes within specified warranty period.
   1. Fluoropolymer Finish: Deterioration includes, but is not limited to, the following:
      a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
      b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
      c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
   2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 EXPOSED METALS

A. Aluminum Sheet: ASTM B 209 (ASTM B 209M), alloy as standard with manufacturer for finish required, with temper to suit forming operations and performance required.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1. Surface: Smooth, flat finish.
2. Exposed Coil-Coated Finishes: Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   a. Three-Coat Fluoropolymer: AAMA 620. System consisting of primer, fluoropolymer color coat, and clear fluoropolymer topcoat, with both color coat and clear topcoat containing not less than 70 percent PVDF resin by weight.
   b. Concealed Surface: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat, with a minimum total dry film thickness of 0.5 mil (0.013 mm).

B. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), alloy and temper recommended by manufacturer for type of use and finish indicated, finished as follows:
1. Exposed High-Performance Organic Finish: Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   a. Three-Coat Fluoropolymer: AAMA 2605. System consisting of primer, fluoropolymer color coat, and clear fluoropolymer topcoat, with both color coat and clear topcoat containing not less than 70 percent PVDF resin by weight.

C. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coating designation.
1. Surface: Smooth, flat finish.
2. Exposed Coil-Coated Finishes: Prepainted by the coil-coating process to comply with ASTM A 755/A 755M. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   a. Three-Coat Fluoropolymer: AAMA 621. System consisting of primer, fluoropolymer color coat, and clear fluoropolymer topcoat, with both color coat and clear topcoat containing not less than 70 percent PVDF resin by weight.

2.2 CONCEALED METALS

A. Aluminum Sheet: ASTM B 209 (ASTM B 209M), alloy and temper recommended by manufacturer for type of use and structural performance indicated, mill finished.

B. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), alloy and temper recommended by manufacturer for type of use and structural performance indicated, mill finished.

C. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coating designation.

2.3 UNDERLAYMENT MATERIALS

A. Felt: ASTM D 226, Type II (No. 30), asphalt-saturated organic felt, nonperforated.

B. Slip Sheet: Building paper, 3-lb/100 sq. ft. (0.16-kg/sq. m) minimum, rosin sized.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2.4 MISCELLANEOUS MATERIALS

A. General: Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items required by manufacturer for a complete installation.

B. Fasteners: Manufacturer's recommended fasteners, suitable for application and designed to meet performance requirements. Furnish the following unless otherwise indicated:
   1. Exposed Penetrating Fasteners: Gasketed screws with hex washer heads matching color of sheet metal.

C. Elastomeric Sealant: ASTM C 920, elastomeric silicone polymer sealant of type, grade, class, and use classifications required by roofing-specialty manufacturer for each application.

D. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D 1187.

E. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required for application.

2.5 COPINGS

A. Copings: Manufactured coping system consisting of formed-metal coping cap in section lengths not exceeding 12 feet (3.6 m), concealed anchorage; corner units, end cap units, and concealed splice plates with same finish as coping caps.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide W.P. Hickman Company; Permasnap Coping System or a comparable product by one of the following:
      a. ATAS International, Inc.
      b. Castle Metal Products.
      c. Cheney Flashing Company.
      d. Metal-Era, Inc.
      e. MM Systems Corporation.
      f. Petersen Aluminum Corporation.
      g. Or approved equal.
   2. Coping-Cap Material: Formed aluminum, 0.063 inch (1.60 mm) thick.
      a. Finish: Three-coat fluoropolymer.
      b. Color: As selected by Architect from manufacturer's full range.
   3. Corners: Factory mitered and mechanically clinched and sealed watertight.
   4. Coping-Cap Attachment Method: Snap-on, fabricated from coping-cap material.
   5. Snap-on-Coping Anchor Plates: Concealed, galvanized-steel sheet, 12 inches (300 mm) wide, with integral cleats.

2.6 ROOF-EDGE DRAINAGE SYSTEMS

A. Downspouts: Plain rectangular complete with mitered elbows, manufactured from the following exposed metal. Furnish with metal hangers, from same material as downspouts, and anchors.
   1. Formed Aluminum: 0.063 inch (1.60 mm) thick.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Parapet Scuppers: Manufactured with closure flange trim to exterior, 4-inch (100-mm) wide wall flanges to interior, and base extending 4 inches (100 mm) beyond cant or tapered strip into field of roof. Fasten gravel guard angles to base of scuppers.
   1. Fabricate from the following exposed metal:
      a. Formed Aluminum: 0.050 inch (1.2 mm) thick.

C. Conductor Heads: Manufactured conductor heads, each with flanged back and stiffened top edge and of dimensions and shape indicated complete with outlet tube that nests into upper end of downspout, exterior flange trim, and built-in overflow.
   1. Fabricate from the following exposed metal:
      a. Formed Aluminum: 0.050 inch (1.2 mm) thick.

D. Aluminum Finish: Three-coat fluoropolymer, clear anodic, or color anodic.
   1. Color: As selected by Architect from manufacturer's full range.

2.7 REGLETS AND COUNTERFLASHINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cheney Flashing Company.
   2. Fry Reglet Corporation.
   3. Hickman Company, W. P.
   4. Metal-Era, Inc.
   5. MM Systems Corporation.
   6. Or approved equal.

B. Reglets: Manufactured units formed to provide secure interlocking of separate reglet and counterflashing pieces, from the following exposed metal:
   1. Formed Aluminum: 0.050 inch (1.27 mm) thick.
   2. Corners: Factory mitered and mechanically clinched and sealed watertight.
   3. Surface-Mounted Type: Provide reglets with slotted holes for fastening to substrate, with neoprene or other suitable weatherproofing washers, and with channel for sealant at top edge.
   4. Concrete Type, Embedded: Provide temporary closure tape to keep reglet free of concrete materials, special fasteners for attaching reglet to concrete forms, and guides to ensure alignment of reglet section ends.
   5. Masonry Type, Embedded: Provide reglets with offset top flange for embedment in masonry mortar joint.

C. Counterflashings: Manufactured units of heights to overlap top edges of base flashings by 4 inches (100 mm) and in lengths not exceeding 12 feet (3.6 m) designed to snap into reglets and compress against base flashings with joints lapped, from the following exposed metal:
   1. Formed Aluminum: 0.032 inch (0.81 mm) thick.

D. Accessories:
   1. Flexible-Flashing Retainer: Provide resilient plastic or rubber accessory to secure flexible flashing in reglet where clearance does not permit use of standard metal counterflashing or where reglet is provided separate from metal counterflashing.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2. Counterflashing Wind-Restraint Clips: Provide clips to be installed before counterflashing to prevent wind uplift of counterflashing lower edge.

E. Aluminum Finish: Three-coat fluoropolymer.
1. Color: As selected by Architect from manufacturer's full range.

2.8 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.

B. Examine walls, roof edges, and parapets for suitable conditions for roof specialties.

C. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 UNDERLAYMENT INSTALLATION

A. Felt Underlayment: Install with adhesive for temporary anchorage to minimize use of mechanical fasteners under roof specialties. Apply in shingle fashion to shed water, with lapped joints of not less than 2 inches (50 mm).

B. Slip Sheet: Install with tape or adhesive for temporary anchorage to minimize use of mechanical fasteners under roof specialties. Apply in shingle fashion to shed water, with lapped joints of not less than 2 inches (50 mm).

3.3 INSTALLATION, GENERAL

A. General: Install roof specialties according to manufacturer's written instructions. Anchor roof specialties securely in place, with provisions for thermal and structural movement. Use fasteners, solder, protective coatings, separators, sealants, and other miscellaneous items as required to complete roof-specialty systems.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1. Install roof specialties level, plumb, true to line and elevation; with limited oil-canning and without warping, jogs in alignment, buckling, or tool marks.
2. Provide uniform, neat seams with minimum exposure of solder and sealant.
3. Install roof specialties to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before manufacture.
4. Torch cutting of roof specialties is not permitted.
5. Do not use graphite pencils to mark metal surfaces.

B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.
1. Coat concealed side of uncoated aluminum roof specialties with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.
2. Underlayment: Where installing metal flashing directly on cementitious or wood substrates, install a course of felt underlayment and cover with a slip sheet.
3. Bed flanges in thick coat of asphalt roofing cement where required by manufacturers of roof specialties for waterproof performance.

C. Expansion Provisions: Allow for thermal expansion of exposed roof specialties.
1. Space movement joints at a maximum of 12 feet (3.6 m) with no joints within 18 inches (450 mm) of corners or intersections unless otherwise shown on Drawings.
2. When ambient temperature at time of installation is between 40 and 70 deg F (4 and 21 deg C), set joint members for 50 percent movement each way. Adjust the setting proportionately for installation at higher ambient temperatures.

D. Fastener Sizes: Use fasteners of sizes that will penetrate wood blocking or sheathing not less than 1-1/4 inches (32 mm) for nails and not less than 3/4 inch (19 mm) for wood screws.

E. Seal joints with butyl sealant as required by roofing-specialty manufacturer.

F. Seal joints as required for watertight construction. Place sealant to be completely concealed in joint. Do not install sealants at temperatures below 40 deg F (4 deg C).

3.4 COPING INSTALLATION

A. Install cleats, anchor plates, and other anchoring and attachment accessories and devices with concealed fasteners.

B. Anchor copings to meet performance requirements.
1. Interlock face and back leg drip edges of snap-on coping cap into cleated anchor plates anchored to substrate at manufacturer's required spacing that meets performance requirements.

3.5 ROOF-EDGE DRAINAGE-SYSTEM INSTALLATION

A. General: Install components to produce a complete roof-edge drainage system according to manufacturer's written instructions. Coordinate installation of roof perimeter flashing with installation of roof-edge drainage system.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Downspouts: Join sections with manufacturer's standard telescoping joints. Provide hangers with fasteners designed to hold downspouts securely to walls and 1 inch (25 mm) away from walls; locate fasteners at top and bottom and at approximately 60 inches (1500 mm) o.c.
   1. Provide elbows at base of downspout to direct water away from building.

C. Parapet Scuppers: Install scuppers through parapet where indicated. Continuously support scupper, set to correct elevation, and seal flanges to interior wall face, over cants or tapered edge strips, and under roofing membrane.
   1. Anchor scupper closure trim flange to exterior wall and seal or solder to scupper.
   2. Loosely lock front edge of scupper with conductor head.
   3. Seal or solder exterior wall scupper flanges into back of conductor head.

D. Conductor Heads: Anchor securely to wall with elevation of conductor top edge 1 inch (25 mm) below scupper discharge.

3.6 REGLET AND COUNTERFLASHING INSTALLATION

A. General: Coordinate installation of reglets and counterflashings with installation of base flashings.

B. Embedded Reglets: See Division 03 Section "Cast-in-Place Concrete" and Division 04 Section "Unit Masonry" for installation of reglets.

C. Surface-Mounted Reglets: Install reglets to receive flashings where flashing without embedded reglets is indicated on Drawings. Install at height so that inserted counterflashings overlap 4 inches (100 mm) over top edge of base flashings.

D. Counterflashings: Insert counterflashings in reglets or other indicated receivers; ensure that counterflashings overlap 4 inches (100 mm) over top edge of base flashings. Lap counterflashing joints a minimum of 4 inches (100 mm) and bed with butyl sealant. Fit counterflashings tightly to base flashings.

3.7 CLEANING AND PROTECTION

A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.

B. Clean and neutralize flux materials. Clean off excess solder and sealants.

C. Remove temporary protective coverings and strippable films as roof specialties are installed. On completion of installation, clean finished surfaces, including removing unused fasteners, metal filings, pop rivet stems, and pieces of flashing. Maintain roof specialties in a clean condition during construction.

D. Replace roof specialties that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Silicone joint sealants
   2. Urethane joint sealants.
   3. Polysulfide joint sealants.
   4. Latex joint sealants.
   5. Acoustical joint sealants.

B. Related Sections:
   1. Division 04 Section "Unit Masonry" for masonry control and expansion joint fillers and gaskets.
   2. Division 08 Section "Glazing" for glazing sealants.
   3. Division 09 Section "Acoustical Tile Ceilings" for sealing edge moldings at perimeters with acoustical sealant.

1.3 PRECONSTRUCTION TESTING

A. Preconstruction Field-Adhesion Testing: Before installing sealants, field test their adhesion to Project joint substrates as follows:
   1. Locate test joints where indicated on Project or, if not indicated, as directed by Architect.
   2. Conduct field tests for each application indicated below:
      a. Each kind of sealant and joint substrate indicated.
   3. Notify Architect seven days in advance of dates and times when test joints will be erected.
   4. Arrange for tests to take place with joint-sealant manufacturer's technical representative present.
      a. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C 1193 or Method A, Tail Procedure, in ASTM C 1521.
         1) For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
   5. Report whether sealant failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. For sealants that fail adhesively, retest until satisfactory adhesion is obtained.
   6. Evaluation of Preconstruction Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing, in absence of other indications of noncompliance with requirements, will be considered satisfactory. Do not use sealants that fail to adhere to joint substrates during testing.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1.4 SUBMITTALS

A. Product Data: For each joint-sealant product indicated.

B. Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.

C. Samples for Verification: For each kind and color of joint sealant required, provide Samples with joint sealants in 1/2-inch (13-mm) wide joints formed between two 6-inch (150-mm) long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

D. Qualification Data: For qualified Installer and testing agency.

E. Joint-Sealant Schedule: Include the following information:
1. Joint-sealant application, joint location, and designation.
2. Joint-sealant manufacturer and product name.
3. Joint-sealant formulation.
4. Joint-sealant color.

F. Qualification Data: For qualified Installer and testing agency.

G. Product Certificates: For each kind of joint sealant and accessory, from manufacturer.

H. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating that sealants comply with requirements.

I. Preconstruction Field-Adhesion Test Reports: Indicate which sealants and joint preparation methods resulted in optimum adhesion to joint substrates based on testing specified in "Preconstruction Testing" Article.

J. Field-Adhesion Test Reports: For each sealant application tested.

K. Warranties: Sample of special warranties.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

B. Source Limitations: Obtain each kind of joint sealant from single source from single manufacturer.

C. Product Testing: Test joint sealants using a qualified testing agency.
1. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.

1.6 PROJECT CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F (5 deg C).
2. When joint substrates are wet.
3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.7 WARRANTY

A. Special Installer's Warranty: Manufacturer's standard form in which Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
   1. Warranty Period: Two years from date of Substantial Completion.

B. Special Manufacturer's Warranty: Manufacturer's standard form in which joint-sealant manufacturer agrees to furnish joint sealants to repair or replace those that do not comply with performance and other requirements specified in this Section within specified warranty period.
   1. Warranty Period: Five years from date of Substantial Completion.

C. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:
   1. Movement of the structure caused by structural settlement or errors attributable to design or construction resulting in stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
   2. Disintegration of joint substrates from natural causes exceeding design specifications.
   3. Mechanical damage caused by individuals, tools, or other outside agents.
   4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer based on testing and field experience.

B. Liquid-Applied Joint Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied joint sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.
   1. Suitability for Immersion in Liquids. Where sealants are indicated for Use I for joints that will be continuously immersed in liquids, provide products that have undergone testing according to ASTM C 1247. Liquid used for testing sealants is deionized water, unless otherwise indicated.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2.2 SILICONE JOINT SEALANTS

A. Single-Component, Nonsag, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 50, for Use NT.
   1. Products: Subject to compliance with requirements, provide one of the following; or approved equal.
      a. BASF Building Systems; Omniseal 50.
      b. Dow Corning Corporation; 795.
      c. GE Advanced Materials - Silicones; SilPruf NB SCS9000.
      d. May National Associates, Inc.; Bondaflex Sil 295.
      e. Pecora Corporation; 895NST.
      f. Sika Corporation, Construction Products Division; SikaSil-C995.
      g. Tremco Incorporated; Spectrem 3.

B. Single-Component, Pourable, Traffic-Grade, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade P, Class 100/50, for Use T.
   1. Products: Subject to compliance with requirements, provide one of the following; or approved equal.
      a. Dow Corning Corporation; SL Parking Structure Sealant.
      b. May National Associates, Inc.; Bondaflex Sil 728 SL.
      c. Pecora Corporation; 300 SL.
      d. Tremco Incorporated; Spectrem 900 SL.

C. Mildew-Resistant, Single-Component, Nonsag, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 25, for Use NT.
   1. Products: Subject to compliance with requirements, provide one of the following; or approved equal.
      a. Pecora Corporation; 898.
      b. Tremco Incorporated; Tremsil 200 Sanitary.

2.3 URETHANE JOINT SEALANTS

A. Single-Component, Nonsag, Urethane Joint Sealant: ASTM C 920, Type S, Grade NS, Class 25, for Use NT.
   1. Products: Subject to compliance with requirements, provide one of the following; or approved equal.
      a. BASF Building Systems; Sonolastic Ultra.
      b. May National Associates, Inc.; Bondaflex PUR 25.
      c. Pecora Corporation; Dynatrol I-XL.
      d. Polymeric Systems, Inc.; Flexiprene 1000.
      e. Sika Corporation, Construction Products Division; Sikaflex - 1a.
      f. Tremco Incorporated; Vulkem 116.

B. Single-Component, Nonsag, Traffic-Grade, Urethane Joint Sealant: ASTM C 920. Type S, Grade NS, Class 25, for Use T.
   1. Products: Subject to compliance with requirements, provide one of the following; or approved equal.
      a. BASF Building Systems; Sonolastic Ultra.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

b. May National Associates, Inc.; Bondaflex PUR 40 FC.
c. Sika Corporation, Construction Products Division; Sikaflex - 1a.
d. Tremco Incorporated; Vulkem 116.

C. Single-Component, Pourable, Traffic-Grade, Urethane Joint Sealant: ASTM C 920, Type S, Grade P, Class 25, for Use T.
1. Products: Subject to compliance with requirements, provide one of the following; or approved equal.
a. BASF Building Systems; SL 1.
b. May National Associates, Inc.; Bondaflex PUR 35 SL.
c. Pecora Corporation; Urexpan NR-201.
d. Polymeric Systems, Inc.; Flexiprene 952.
e. Sika Corporation. Construction Products Division; Sikaflex - 1CSL.

D. Multicomponent, Pourable, Traffic-Grade, Urethane Joint Sealant: ASTM C 920. Type M, Grade P, Class 25, for Use T and I.
1. Products: Subject to compliance with requirements, provide one of the following; or approved equal.
a. Pecora Corporation; Urexpan NR-200.
b. Tremco Incorporated; Vulkem 245.

2.4 POLYSULFIDE JOINT SEALANTS

A. Immersible, Multicomponent Nonsag, Traffic-Grade, Polysulfide Joint Sealant: ASTM C 920, Type M, Grade NS, Class 25, for Use T and Use I.
1. Products: Subject to compliance with requirements, provide one of the following; or approved equal.
a. BASF Building Systems; Sonolastic Polysulfide Sealant.
b. Pecora Corporation; Synthacalk GC-2+.
c. PolySpec Corp.; Thiokol 2235M.

2.5 LATEX JOINT SEALANTS

A. Latex Joint Sealant: Acrylic latex or siliconized acrylic latex, ASTM C 834, Type OP, Grade NF.
1. Products: Subject to compliance with requirements, provide one of the following; or approved equal.
a. BASF Building Systems; Sonolac.
b. May National Associates, Inc.; Bondaflex Sil-A 700.
c. Pecora Corporation; AC-20+.
d. Tremco Incorporated; Tremflex 834.

2.6 ACOUSTICAL JOINT SEALANTS

A. Acoustical Joint Sealant: Manufacturer's standard nonsag, paintable, nonstaining latex sealant complying with ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1. Products: Subject to compliance with requirements, provide one of the following; or approved equal.
   a. Pecora Corporation; AC-20 FTR.
   b. USG Corporation; SHEETROCK Acoustical Sealant.

2.7 JOINT SEALANT BACKING

A. General: Provide sealant backings of material that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

B. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin), Type B (bicellular material with a surface skin), or any of the preceding types, as approved in writing by joint-sealant manufacturer for joint application indicated, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.
   1. Do not use Type O backing for horizontal traffic joints.

C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

2.8 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:
   1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
   2. Clean porous joint substrate surfaces by brushing, grinding, blast cleaning, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:
      a. Concrete.
      b. Masonry.
   3. Remove laitance and form-release agents from concrete.
   4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:
      a. Metal.
      b. Glass.

B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
   1. Do not leave gaps between ends of sealant backings.
   2. Do not stretch, twist, puncture, or tear sealant backings.
   3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
   1. Place sealants so they directly contact and fully wet joint substrates.
   2. Completely fill recesses in each joint configuration.
   3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
   1. Remove excess sealant from surfaces adjacent to joints.
   2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
   3. Provide concave joint profile per Figure 8A in ASTM C 1193, unless otherwise indicated.
   4. Provide recessed joint configuration of recess depth and at locations indicated per Figure 8C in ASTM C 1193.
      a. Use masking tape to protect surfaces adjacent to recessed tooled joints.

G. Installation of Preformed Silicone-Sealant System: Comply with the following requirements:
   1. Apply masking tape to each side of joint, outside of area to be covered by sealant system.
   2. Apply silicone sealant to each side of joint to produce a bead of size complying with preformed silicone-sealant system manufacturer's written instructions and covering a bonding area of not less than 3/8 inch (10 mm). Hold edge of sealant bead 1/4 inch (6 mm) inside masking tape.
   3. Within 10 minutes of sealant application, press silicone extrusion into sealant to wet extrusion and substrate. Use a roller to apply consistent pressure and ensure uniform contact between sealant and both extrusion and substrate.
   4. Complete installation of sealant system in horizontal joints before installing in vertical joints. Lap vertical joints over horizontal joints. At ends of joints, cut silicone extrusion with a razor knife.

H. Acoustical Sealant Installation: At sound-rated assemblies and elsewhere as indicated, seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C 919 and with manufacturer's written recommendations.

3.4 FIELD QUALITY CONTROL

A. Field-Adhesion Testing: Field test joint-sealant adhesion to joint substrates as follows:
   1. Extent of Testing: Test completed and cured sealant joints as follows:
      a. Perform 10 tests for the first 1000 feet (300 m) of joint length for each kind of sealant and joint substrate.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

b. Perform 1 test for each 1000 feet (300 m) of joint length thereafter or 1 test per each floor per elevation.

2. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C 1193 or Method A, Tail Procedure, in ASTM C 1521.
   a. For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
3. Inspect tested joints and report on the following:
   a. Whether sealants filled joint cavities and are free of voids.
   b. Whether sealant dimensions and configurations comply with specified requirements.
   c. Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. Compare these results to determine if adhesion passes sealant manufacturer's field-adhesion hand-pull test criteria.
4. Record test results in a field-adhesion-test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant fill, sealant configuration, and sealant dimensions.
5. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.

B. Evaluation of Field-Adhesion Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

3.5 CLEANING

A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.6 PROTECTION

A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

3.7 JOINT-SEALANT SCHEDULE

A. Joint-Sealant Application: Exterior joints in horizontal traffic surfaces.
   1. Joint Locations:

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

a. Isolation and contraction joints in cast-in-place concrete slabs.
b. Joints between different materials listed above.
c. Other joints as indicated.

2. Silicone Joint Sealant: Single component, pourable, traffic grade, neutral curing.
3. Joint-Sealant Color: Match adjacent material color designated by Architect and as selected by Architect from manufacturer's full range of colors.

B. Joint-Sealant Application: Exterior joints in vertical surfaces and horizontal nontraffic surfaces.
1. Joint Locations:
a. Construction joints in cast-in-place concrete.
b. Control and expansion joints in unit masonry.
c. Joints between different materials listed above.
d. Perimeter joints between materials listed above and frames of doors, windows and louvers.
2. Silicone Joint Sealant: Single component, nonsag, neutral curing, Class 50**.**
3. Joint-Sealant Color: Match adjacent material color designated by Architect and as selected by Architect from manufacturer's full range of colors.

C. Joint-Sealant Application: Mildew-resistant interior joints in vertical surfaces and horizontal nontraffic surfaces.
1. Joint Sealant Location:
a. Joints between plumbing fixtures and adjoining walls, floors, and counters.
b. Other joints as indicated.
2. Joint Sealant: Mildew resistant, single component, nonsag, neutral curing, Silicone.
3. Joint-Sealant Color: Match adjacent material color designated by Architect and as selected by Architect from manufacturer's full range of colors.

D. Joint-Sealant Application: Exterior joints in horizontal traffic surfaces subject to water immersion.
1. Joint Locations:
a. Other joints as indicated.
2. Polysulfide Joint Sealant: Immersible, multicomponent, nonsag, traffic grade.
3. Joint-Sealant Color: Match adjacent material color designated by Architect and as selected by Architect from manufacturer's full range of colors.

E. Joint-Sealant Application: Exterior joints in horizontal traffic surfaces.
1. Joint Locations:
a. Isolation and contraction joints in cast-in-place concrete slabs.
b. Joints between plant-precast structural concrete slabs.
c. Joints between different materials listed above.
d. Other joints as indicated.
2. Urethane Joint Sealant: Multicomponent, pourable, traffic grade, Class 25.
3. Joint-Sealant Color: Match adjacent material color designated by Architect and as selected by Architect from manufacturer's full range of colors.

F. Joint-Sealant Application: Interior joints in horizontal traffic surfaces.
1. Joint Locations:
a. Isolation joints in cast-in-place concrete slabs.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2. Urethane Joint Sealant: Single component, nonsag or pourable, traffic grade.
3. Joint-Sealant Color: Match adjacent material color designated by Architect and as selected by Architect from manufacturer's full range of colors.

G. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces.
   1. Joint Locations:
      a. Control and expansion joints on exposed interior surfaces of exterior walls.
      b. Perimeter joints of exterior openings where indicated.
      c. Vertical joints on exposed surfaces of interior unit masonry and concrete walls and partitions.
      d. Joints on underside of plant-precast structural concrete beams and planks.
   2. Urethane Joint Sealant: Single component, nonsag, nontraffic grade, Class 25.
   3. Joint-Sealant Color: Match adjacent material color designated by Architect and as selected by Architect from manufacturer's full range of colors.

H. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces.
   1. Joint Locations:
      a. Perimeter joints between interior wall surfaces and frames of interior doors, windows, and elevator entrances.
      b. Joints at top of floor base cap trim.
      c. Other joints as indicated.
   2. Joint Sealant: Latex.
   3. Joint-Sealant Color: Match adjacent material color designated by Architect and as selected by Architect from manufacturer's full range of colors.

I. Joint-Sealant Application: Interior acoustical joints in vertical surfaces and horizontal nontraffic surfaces.
   1. Joint Location:
      a. Acoustical joints where indicated.
      b. Other joints as indicated.
   2. Joint Sealant: Acoustical.
   3. Joint-Sealant Color: As selected by Architect from manufacturer's full range.

J. Joint-Sealant Application: Exterior joints in vertical surfaces and horizontal nontraffic surfaces.
   1. Joint Locations:
      a. Construction joints in cast-in-place concrete.
      b. Control and expansion joints in unit masonry.
      c. Joints between different materials listed above.
      d. Other joints as indicated.
   2. Preformed Joint Sealant: Preformed silicone.
   3. Joint-Sealant Color: Match adjacent material color designated by Architect and as selected by Architect from manufacturer's full range of colors.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section Includes the following:
   1. Fiberglass Reinforced Plastic (FRP) Doors
   2. Fiberglass Resin Transfer Molded Door Frames

1.3 RELATED SECTIONS

A. Related Sections Include The Following:
   1. Division 04 Section "Unit Masonry" for embedding anchors for FRP work into masonry construction.
   2. Division 08 Section "Door Hardware" for door hardware for FRP doors.
   3. Division 08 Section "Glazing".
   4. Division 26 Sections for electrical connections including conduit and wiring for door controls and operators.

1.4 QUALITY ASSURANCE

A. Referenced Standards
   1. ASTM D 635 - Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position
   2. ASTM E 84 - Standard Test Method for a Surface Burning Characteristics of Building Materials.
   3. Laminate Properties
      a. ASTM D 882 Tensile Strength
      b. ASTM D 790 Flexural Strength
      c. ASTM D 2583 Barcol Hardness
      d. ASTM D 256 Impact Resistance
      e. ASTM D 792 Density/Specific Gravity Of Laminate
      f. ASTM D 1761 Mechanical Fasteners
   4. Core Properties
      a. ASTM C 177 Thermal Properties
      b. ASTM D 1622 Density/Specific Gravity
      c. ASTM E 84 Surface Burning Characteristics
      d. WDMA TM-10 and TM-5 Firestop ASTM E 152 U.L. 10(b)

B. Qualifications:
   1. Manufacturer Qualifications: A company specialized in the manufacture of fiberglass reinforced plastic (FRP) doors and frames as specified herein.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2. Installer Qualifications: An experienced installer who has completed fiberglass door and frame installations similar in material, design, and extent to those indicated and whose work has resulted in construction with a record of successful in-service performance.
3. Source Limitations: Obtain fiberglass reinforced plastic doors and frames through one source fabricated from a single manufacturer, including fire rated fiberglass frames.
4. Source Limitations: Hardware and accessories for all FRP doors as specified in Division 08 Section "Door Hardware" should be provided and installed by the fiberglass door and frame manufacturer.
5. Source Limitations: Glass for windows in doors shall be furnished and installed by door and frame manufacturer in accordance with related section, Division 08 Section "Glazing".

1.5 SUBMITTALS

A. Product Data:
1. Acknowledgment that products submitted meet requirements of standards referenced.
2. Manufacturer shall provide certificate of compliance with current local and federal regulations as it applies to the manufacturing process.
3. Manufacturer's installation instructions.
4. Schedule of doors and frames indicating the specific reference numbers as used on drawings, door type, frame type, size, handing and applicable hardware.
5. Details of core and edge construction. Include factory-construction specifications.
6. Certification of manufacturer's qualifications.

B. Shop Drawings: Include the following:
1. Summary door schedule indicating the specific reference numbers as used on owner’s drawings, with columns noting door type, frame type, size, handing, accessories and hardware.
2. A drawing depicting front and rear door elevations showing hardware with bill of material for each door.
3. Drawing showing dimensional location of each hardware item and size of each door.
4. Individual part drawing and specifications for each hardware item and FRP part or product.
5. Construction and mounting detail for each frame type.

C. Samples for Initial Selection:
1. Provide one 21 x 18 inch completely assembled (hinged) door and frame corner section, with faces and edges representing typical color and finish. One edge should be exposed for view of interior door and frame composition. Sample should include 6 inch lite opening as well as standard cutouts for hinges and strike plates.

D. Operation and Maintenance Manuals:
1. Include recommended methods and frequency for maintaining optimum condition of fiberglass doors and frames under anticipated traffic and use conditions.
2. Include one set of final as built drawings with the same requirements as mentioned in Section B above.
3. Include certificate of warranty for door and frame listing specific door registration numbers.
4. Include hardware data sheets and hardware manufacturer's warranties.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Each door and frame should be delivered individually crated for protection from damage in cardboard containers, clearly marked with project information, door location, specific reference number as shown on drawings, and shipping information. Each crate should contain all fasteners necessary for installation as well as complete installation instructions.

B. Doors should be stored in the original container out of inclement weather for protection against the elements.

C. Handle doors pursuant to the manufacturer's recommendations as posted on outside of crate.

1.7 WARRANTY

A. Warranty all fiberglass doors and frames for a period of 25 years against failure due to corrosion. Additionally, warranty all fiberglass doors and frames on materials and workmanship for a period of 10 years, including warp, separation or delamination, and expansion of the core.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following; or approved equal.
   1. Chem-Pruf Door Co., Ltd.
   2. FIB-R-DOR, Division of Advance Fiberglass, Inc.
   3. Edgewater FRP Doors.
   4. Tiger Door, Division of Overly Door Company.

2.2 FRP DOORS

A. Doors shall be made of fiberglass reinforced plastic (FRP) using chemically proven resins resistant to contaminants typically found in the environment for which these specifications are written. Doors shall be 1 3/4 inch thick and of flush construction, having no seams or cracks. All doors up to 4'0 x 8'0 shall have equal diagonal measurements with a maximum tolerance of +/- 1/32 inch.

B. Door Plates shall be 1/8 inch thick, molded in one continuous piece, starting with a 25 mil gelcoat of the color specified, integrally molded with at least two layers of 1.5 ounce per square foot fiberglass mat and one layer of 16 ounce per square yard unidirectional roving. Total plate weight of 0.97 lbs per square foot at a ratio of 30/70 glass to resin.

C. Stiles and Rails shall be constructed starting from the outside toward the inside, of a 25 mil gel coat of the color specified followed by a matrix of at least three layers of 1.5 ounce per square foot of fiberglass mat. The stile and rail shall be molded in one continuous piece to a U-shaped configuration and to the exact dimensions of the door. No miter joints or disparate materials shall be used to form the once-piece stile and rail.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

D. Core material shall be 2 psf expanded polyurethane foam, kraft honeycomb, or mineral core, which completely fills all voids between the door plates.

E. Internal Reinforcement shall be firestop of sufficient amount to adequately support required hardware and function of same.

F. Finish of door and frame shall be identical in color and texture. At time of manufacture, 25 mil of resin-rich gelcoat must be integrally molded into both the door and frame. Secondary painting to achieve color is not acceptable.

G. Window openings shall be provided for at time of manufacture and shall be completely sealed so that the interior of the door is not exposed to the environment. Fiberglass retainers which hold the glazing in place shall be resin transfer molded with a profile that drains away from glazing. The retainers must match the color, texture and finish of the door plates. Glass shall be furnished and installed by door and frame manufacturer.

H. Louver openings shall be sealed in the same manner as the window openings. Louvers are to be solid fiberglass inverted "V" vanes and shall match the color, texture and finish of the door plates.

2.3 FRAMES

A. Frames shall be fiberglass and manufactured using the resin transfer method in closed rigid molds to assure uniformity in color and size. Beginning with a minimum 25 mil gel coat and a minimum of two layers continuous strand fiberglass mat saturated with resin, the frame will be of one-piece construction with molded stop. All frame profiles up to 3/4" will be solid fiberglass. All frame profiles greater than 3/4" shall have a core material of 2 psf polyurethane foam. Metal frames or pultruded fiberglass frames will not be accepted.

B. Finish of frame shall be identical in color and texture to the door. 25 mil resin rich gel coat will be integrally molded into the frame at time of manufacture. Secondary painting to achieve color is not acceptable.

C. Jamb/Header connection shall be coped by CNC for tight fit.

D. Internal Reinforcement shall be continuous within the structure to allow for mounting of specified hardware. Material shall be completely non-organic with a minimum hinge screw holding value of 656 lbs. Frame screw holding value to accommodate screw shall be minimum of 1,000 lbs per screw. Documented strength of frame screw holding value after third insert must be submitted. Dissimilar materials, such as steel, will be deemed unacceptable as reinforcement for hardware attachment.

E. Mortises for hardware shall be accurately machined by CNC to hold dimensions to +/- 0.010 inch in all three axis.

F. Hinge pockets shall be accurately machined by CNC to facilitate heavy duty hinges at all hinge locations, using spacers when standard weight hinges are used.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2.4 HARDWARE

A. Refer to Division 08 Section "Door Hardware".

B. Due to the special nature of the material in this section, all related hardware as specified must be furnished and installed by the General Contractor.

2.5 FINISHES

A. All FRP doors and frames shall be factory pre-finished.
   1. Finish: Manufacturer's standard chemical-resistant two-part polyurethane topcoat.
   2. Sheen: Semi-gloss.
   3. Color: Selected by Architect from manufacturer's standard color chart.

PART 3 - EXECUTION

3.1 INSTALLATION CONDITIONS

A. Verification of Conditions
   1. Openings are correctly prepared to receive doors and frames.
   2. Openings are correct size and depth in accordance with shop drawings or submittals.

B. Installer’s Examination
   1. Have the installer examine conditions under which construction activities of this section are to be performed and submit a written report if conditions are unacceptable.
   2. Transmit two copies of installer’s report to Architect within 24 hours of receipt.
   3. Beginning construction activities of this section before unacceptable conditions have been corrected is prohibited.

3.2 INSTALLATION

A. Install door-opening assemblies in accordance with shop drawings and manufacturer’s printed installation instructions, using installation methods and materials specified in installation instructions.

B. Field alteration of doors or frames to accommodate field conditions is strictly prohibited.

C. Site tolerances: Maintain plumb and level tolerance specified in manufacturer’s printed installation instructions.

D. Fire labeled doors and frames must be installed in strict accordance with manufacturer’s instructions and the latest revision of NFPA 80.

3.3 ADJUSTING

A. Adjust doors in accordance with door manufacturer’s maintenance instructions to swing open and shut without binding and to remain in place at any angle without being moved by gravitational influence.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Adjust door hardware to operate correctly in accordance with hardware manufacturer's maintenance instructions.

3.4 CLEANING

A. Clean surfaces of door opening assemblies and exposed door hardware in accordance with respective manufacturer's maintenance instructions.

3.5 PROTECTION OF INSTALLED PRODUCTS

A. Protect door opening assemblies and door hardware from damage by subsequent construction activities until final inspection.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Insulated service doors.

B. Related Sections:
   1. Division 04 Section "Unit Masonry" for embedding anchors for overhead coiling doors.
   2. Division 05 Section "Metal Fabrications" for miscellaneous steel supports.
   3. Division 26 Sections for electrical service and connections for powered operators and accessories.

1.3 PERFORMANCE REQUIREMENTS

A. Structural Performance, Exterior Doors: Exterior overhead coiling doors shall withstand the wind loads, the effects of gravity loads, and loads and stresses within limits and under conditions indicated according to SEI/ASCE 7.
   1. Wind Loads: Uniform pressure (velocity pressure) of 20 lbf/sq. ft. (960 Pa), acting inward and outward.
   2. Wind Load Requirements: Meet the design positive and negative wind load pressures. See drawings for wind load requirements.
   3. Deflection Limits: Design overhead coiling doors to withstand design wind load without evidencing permanent deformation or disengagement of door components.

B. Operation Cycles: Provide overhead coiling door components and operators capable of operating for not less than number of cycles indicated for each door. One operation cycle is complete when a door is opened from the closed position to the fully open position and returned to the closed position.

1.4 SUBMITTALS

A. Product Data: For each type and size of overhead coiling door and accessory. Include the following:
   1. Construction details, material descriptions, dimensions of individual components, profiles for slats, and finishes.
   2. Rated capacities, operating characteristics, electrical characteristics, and furnished accessories.

B. Shop Drawings: For each installation and for special components not dimensioned or detailed in manufacturer's product data. Include plans, elevations, sections, details, and attachments to other work.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.
   a. Differentiate between manufacturer-installed and field-installed wiring and between components provided by door manufacturer and those provided by others.

C. Samples for Initial Selection: Manufacturer's finish charts showing full range of colors and textures available for units with factory-applied finishes.
   1. Include similar Samples of accessories involving color selection.

D. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below.
   1. Curtain Slats: 12 inches (305 mm) long.
   2. Bottom Bar: 6 inches (150 mm) long.
   3. Guides: 6 inches (150 mm) long.
   4. Brackets: 6 inches (150 mm) square.
   5. Hood: 6 inches (150 mm) square.

E. Qualification Data: For qualified installer.

F. Maintenance Data: For overhead coiling doors to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for both installation and maintenance of units required for this Project.

B. Source Limitations: Obtain overhead coiling doors from single source from single manufacturer.
   1. Obtain operators and controls from overhead coiling door manufacturer.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Regulatory Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation barriers Compliance Board's ADA-ABA Accessibility Guidelines.

PART 2 - PRODUCTS

2.1 DOOR CURTAIN MATERIALS AND CONSTRUCTION

A. Door Curtains: Fabricate overhead coiling-door curtain of interlocking metal slats, designed to withstand wind loading indicated, in a continuous length for width of door without splices. Unless otherwise indicated, provide slats of thickness and mechanical properties recommended by door manufacturer for performance, size, and type of door indicated, and as follows:

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1. Steel Door Curtain Slats: Zinc-coated (galvanized), cold-rolled structural steel sheet; complying with ASTM A 653/A 653M, with G90 (Z275) zinc coating; nominal sheet thickness (coated) of 0.028 inch (0.71 mm) and as required to meet requirements.
2. Insulation: Fill slats for insulated doors with manufacturer's standard thermal insulation complying with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, according to ASTM E 84. Enclose insulation completely within slat faces.
3. Metal Interior Curtain-Slat Facing: Match metal of exterior curtain-slat face.

B. Endlocks and Windlocks for Service Doors: Malleable-iron casings galvanized after fabrication, secured to curtain slats with galvanized rivets, or high-strength nylon. Provide locks on not less than alternate curtain slats for curtain alignment and resistance against lateral movement.
1. Bottom Bar for Service Doors: Consisting of two angles, each not less than 1-1/2 by 1-1/2 by 1/8 inch (38 by 38 by 3 mm) thick; fabricated from manufacturer's standard hot-dip galvanized steel, stainless steel, or aluminum extrusions to match curtain slats and finish.

C. Curtain Jamb Guides: Manufacturer's standard angles or channels and angles of same material and finish as curtain slats unless otherwise indicated, with sufficient depth and strength to retain curtain, to allow curtain to operate smoothly, and to withstand loading. Slot bolt holes for guide adjustment. Provide removable stops on guides to prevent overtravel of curtain, and a continuous bar for holding windlocks.

2.2 HOOD

A. General: Form sheet metal hood to entirely enclose coiled curtain and operating mechanism at opening head. Contour to fit end brackets to which hood is attached. Roll and reinforce top and bottom edges for stiffness. Form closed ends for surface-mounted hoods and fascia for any portion of between-jamb mounting that projects beyond wall face. Equip hood with intermediate support brackets as required to prevent sagging.
1. Galvanized Steel: Nominal 0.028-inch (0.71-mm) thick, hot-dip galvanized steel sheet with G90 (Z275) zinc coating, complying with ASTM A 653/A 653M.
2. Exterior-Mounted Doors: Fabricate hood to act as weather protection and with a perimeter sealant-joint-bead profile for applying joint sealant.

2.3 LOCKING DEVICES

A. Slide Bolt: Fabricate with side-locking bolts to engage through slots in tracks for locking by padlock, located on both left and right jamb sides, operable from coil side.

B. Locking Device Assembly: Fabricate with cylinder lock, spring-loaded dead bolt, operating handle, cam plate, and adjustable locking bars to engage through slots in tracks.
1. Lock Cylinders: Provide cylinders specified in Division 08 Section "Door Hardware."

C. Chain Lock Keeper: Suitable for padlock.

D. Safety Interlock Switch: Equip power-operated doors with safety interlock switch to disengage power supply when door is locked.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

E. Where door unit is power operated, provide fail safe, time-delayed releasing device to prevent mechanical drop during momentary power failure.

2.4 CURTAIN ACCESSORIES

A. Weatherseals: Equip each exterior door with weather-stripping gaskets fitted to entire perimeter of door for a weathertight installation, unless otherwise indicated.
   1. At door head, use 1/8-inch (3-mm) thick, replaceable, continuous sheet secured to inside of hood.
   2. At door jambs, use replaceable, adjustable, continuous, flexible, 1/8-inch (3-mm) thick seals of flexible vinyl, rubber, or neoprene.

B. Push/Pull Handles: Equip each push-up-operated or emergency-operated door with lifting handles on each side of door, finished to match door.
   1. Provide pull-down straps or pole hooks for doors more than 84 inches (2130 mm) high.

2.5 COUNTERBALANCING MECHANISM

A. General: Counterbalance doors by means of manufacturer's standard mechanism with an adjustable-tension steel helical torsion spring mounted around a steel shaft and contained in a spring barrel connected to top of curtain with barrel rings. Use grease-sealed bearings or self-lubricating graphite bearings for rotating members.

B. Counterbalance Barrel: Fabricate spring barrel of manufacturer's standard hot-formed, structural-quality, welded or seamless carbon-steel pipe, of sufficient diameter and wall thickness to support rolled-up curtain without distortion of slats and to limit barrel deflection to not more than 0.03 in./ft. (2.5 mm/m) of span under full load.

C. Spring Balance: One or more oil-tempered, heat-treated steel helical torsion springs. Size springs to counterbalance weight of curtain, with uniform adjustment accessible from outside barrel. Secure ends of springs to barrel and shaft with cast-steel barrel plugs.

D. Torsion Rod for Counterbalance Shaft: Fabricate of manufacturer's standard cold-rolled steel, sized to hold fixed spring ends and carry torsional load.

E. Brackets: Manufacturer's standard mounting brackets of either cast iron or cold-rolled steel plate.

2.6 MANUAL DOOR OPERATORS

A. Equip door with manufacturer's recommended manual door operator unless another type of door operator is indicated.

B. Push-up Door Operation: Design counterbalance mechanism so required lift or pull for door operation does not exceed 25 lbf (111 N).

C. Chain-Hoist Operator: Consisting of endless steel hand chain, chain-pocket wheel and guard, and gear-reduction unit with a maximum 30 lbf (133 N) force for door operation. Provide alloy-steel hand chain with chain holder secured to operator guide.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2.7 ELECTRIC DOOR OPERATORS

A. General: Electric door operator assembly of size and capacity recommended and provided by door manufacturer for door and operation-cycles requirement specified, with electric motor and factory-prewired motor controls, starter, gear-reduction unit, solenoid-operated brake, clutch, remote-control stations, control devices, integral gearing for locking door, and accessories required for proper operation.
   1. Comply with NFPA 70.
   2. Provide control equipment complying with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6, with NFPA 70 Class 2 control circuit, maximum 24 V, ac or dc.

B. Usage Classification: Electric operator and components capable of operating for not less than number of cycles per hour indicated for each door.

C. Door Operator Location(s): Operator location indicated for each door.
   1. Top-of-Hood Mounted: Operator is mounted to the right or left door head plate with the operator on top of the door-hood assembly and connected to the door drive shaft with drive chain and sprockets. Headroom is required for this type of mounting.
   2. Front-of-Hood Mounted: Operator is mounted to the right or left door head plate with the operator on coil side of the door-hood assembly and connected to the door drive shaft with drive chain and sprockets. Front clearance is required for this type of mounting.
   3. Wall Mounted: Operator is mounted to the inside front wall on the left or right side of door and connected to door drive shaft with drive chain and sprockets. Side room is required for this type of mounting. Wall mounted operator can also be mounted above or below shaft; if above shaft, headroom is required.

D. Electric Motors: High-starting torque, reversible, continuous duty, Class A insulated, complying with NEMA MG1, Design B; with overload protection.
   1. Electrical Characteristics:
      a. Phase: Polyphase, medium induction type.
      b. Volts: 480 V.
      c. Hertz: 60.
   2. Motor Type and Controller: Reversible motor and controller (disconnect switch) for motor exposure indicated.
   3. Motor Size: Minimum size as indicated. If not indicated, large enough to start, accelerate, and operate door in either direction from any position, at a speed not less than 8 in./sec. (203 mm/s) and not more than 12 in./sec. (305 mm/s), without exceeding nameplate ratings or service factor.
   4. Operating Controls, Controllers (Disconnect Switches), Wiring Devices, and Wiring: Manufacturer's standard unless otherwise indicated.
   5. Coordinate wiring requirements and electrical characteristics of motors and other electrical devices with building electrical system and each location where installed.

E. Limit Switches: Equip each motorized door with adjustable switches interlocked with motor controls and set to automatically stop door at fully opened and fully closed positions.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

F. Obstruction Detection Device: Equip motorized door with indicated external automatic safety sensor capable of protecting full width of door opening. For non-fire-rated doors, activation of device immediately stops and reverses downward door travel. For fire-rated doors, activation delays closing.
   1. Photoelectric Sensor: Manufacturer's standard system designed to detect an obstruction in door opening without contact between door and obstruction.
      a. Self-Monitoring Type: Designed to interface with door operator control circuit to detect damage to or disconnection of sensing device. When self-monitoring feature is activated, door closes only with sustained pressure on close button.

G. Remote-Control Station: Momentary-contact, three-button control station with push-button controls labeled "Open," "Close," and "Stop."
   1. Interior units, full-guarded, surface-mounted, heavy-duty type, with general-purpose NEMA ICS 6, Type 1 enclosure.
   2. Exterior units, full-guarded, standard-duty, surface-mounted, weatherproof type, NEMA ICS 6, Type 4 enclosure, key operated.

H. Emergency Manual Operation: Equip each electrically powered door with capability for emergency manual operation. Design manual mechanism so required force for door operation does not exceed 30 lbf (133 N).

I. Emergency Operation Disconnect Device: Equip operator with hand-operated disconnect mechanism for automatically engaging manual operator and releasing brake for emergency manual operation while disconnecting motor without affecting timing of limit switch. Mount mechanism so it is accessible from floor level. Include interlock device to automatically prevent motor from operating when emergency operator is engaged.

J. Motor Removal: Design operator so motor may be removed without disturbing limit-switch adjustment and without affecting emergency manual operation.

K. Keyed Push Button Station: Access only to those having keys.

L. Time Delay System: Allows door to remain open for periods of 15 seconds to 3 minutes, giving pedestrians or vehicles sufficient time to enter or leave, then allow door to automatically close.

2.8 DOOR ASSEMBLY

A. Insulated Service Door: Overhead coiling door formed with curtain of interlocking metal slats.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following; or approved equal.
      a. Cookson Company.
      b. Cornell Iron Works, Inc.
      c. Overhead Door Corporation.
      d. Wayne-Dalton Corp.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Operation Cycles: Not less than 20,000.
   1. Include tamperproof cycle counter.

C. Curtain R-Value: 5.0 deg F x h x sq. ft./Btu (0.881 K x sq. m/W).

D. Door Curtain Material: Galvanized steel.

E. Door Curtain Slats: Flat profile slats of 2-5/8-inch (67-mm) center-to-center height.
   1. Insulated-Slat Interior Facing: Metal.

F. Curtain Jamb Guides: Galvanized steel with exposed finish matching curtain slats. Provide continuous integral wear strips to prevent metal-to-metal contact and to minimize operational noise.

G. Hood: Match curtain material and finish.
   1. Shape: Square.
   2. Mounting: Face of wall.

H. Locking Devices: Equip door with slide bolt for padlock.

I. Electric Door Operator:
   1. Usage Classification: Medium duty, up to 15 cycles per hour.
   2. Operator Location: Front of hood.
   3. Motor Exposure: Interior.
   4. Emergency Manual Operation: Chain type.
   5. Obstruction-Detection Device: Automatic photoelectric sensor; self-monitoring type.
   6. Remote-Control Station: Interior.
   7. Other Equipment: Keyed Push Button Station.

J. Door Finish:
   1. Baked-Enamel Finish: Color as selected by Architect from manufacturer's full range.
   2. Interior Curtain-Slat Facing: Match finish of exterior curtain-slat face.

2.9 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.10 STEEL AND GALVANIZED-STEEL FINISHES

A. Baked-Enamel Finish: Manufacturer's standard baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for cleaning, pretreatment, application, and minimum dry film thickness.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates areas and conditions, with Installer present, for compliance with requirements for substrate construction and other conditions affecting performance of the Work.

B. Examine locations of electrical connections.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install overhead coiling doors and operating equipment complete with necessary hardware, anchors, inserts, hangers, and equipment supports; according to manufacturer's written instructions and as specified.

B. Install overhead coiling doors, hoods, and operators at the mounting locations indicated for each door.

C. Accessibility: Install overhead coiling doors, switches, and controls along accessible routes in compliance with regulatory requirements for accessibility.

D. Install in accordance with Product Control Notice of Approval for approved submittal.

3.3 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
   1. Perform installation and startup checks according to manufacturer's written instructions.
   2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
   3. Test door closing when activated by detector or alarm-connected fire-release system. Reset door-closing mechanism after successful test.

3.4 ADJUSTING

A. Adjust hardware and moving parts to function smoothly so that doors operate easily, free of warp, twist, or distortion.

B. Lubricate bearings and sliding parts as recommended by manufacturer.

C. Adjust seals to provide weathertight fit around entire perimeter.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain overhead coiling doors.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Exterior storefront framing.

1.3 DEFINITIONS

A. ADA/ABA Accessibility Guidelines: U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disability Act (ADA) and Architectural Barriers Act (ABA) Accessibility Guidelines for Buildings and Facilities."

1.4 PERFORMANCE REQUIREMENTS

A. General Performance: Aluminum-framed systems shall withstand the effects of the following performance requirements without exceeding performance criteria or failure due to defective manufacture, fabrication, installation, or other defects in construction:
   1. Movements of supporting structure indicated on Drawings including, but not limited to, story drift and deflection from uniformly distributed and concentrated live loads.
   2. Dimensional tolerances of building frame and other adjacent construction.
   3. Failure includes the following:
      a. Deflection exceeding specified limits.
      b. Thermal stresses transferring to building structure.
      c. Framing members transferring stresses, including those caused by thermal and structural movements, to glazing.
      d. Noise or vibration created by wind and by thermal and structural movements.
      e. Loosening or weakening of fasteners, attachments, and other components.
      f. Sealant failure.
      g. Failure of operating units.

B. Structural Loads:
   1. Design Pressures: (windload requirements): Meet the calculated positive and negative design (windload) pressures as indicated on the drawings.
   2. Wind Loads: As indicated on Drawings.
      a. Basic Wind Speed: 90 mph (40 m/s).
      b. Importance Factor: 1w = 1.0.
      c. Exposure Category: C.
   3. Seismic Loads: As indicated on Drawings.

C. Deflection of Framing Members:
   1. Deflection Normal to Wall Plane: Limited to 1/175 of clear span for spans up to 13 feet 6 inches (4.1 m) and to 1/240 of clear span plus 1/4 inch (6.35 mm) for spans greater than 13 feet 6 inches (4.1 m) or an amount that restricts edge deflection of individual glazing lites to 3/4 inch (19 mm), whichever is less.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2. Deflection Parallel to Glazing Plane: Limited to L/360 of clear span or 1/8 inch (3.2 mm), whichever is smaller.

D. Structural-Test Performance: Provide aluminum-framed systems tested according to ASTM E 330 as follows:
1. When tested at positive and negative wind-load design pressures, systems do not evidence deflection exceeding specified limits.
2. When tested at 150 percent of positive and negative wind-load design pressures, systems, including anchorage, do not evidence material failures, structural distress, and permanent deformation of main framing members exceeding 0.2 percent of span.
3. Test Durations: As required by design wind velocity, but not fewer than 10 seconds.

E. Air Infiltration: Provide aluminum-framed systems with maximum air leakage through fixed glazing and framing areas of 0.06 cfm/sq. ft. (0.03 L/s per sq. m) of fixed wall area when tested according to ASTM E 283 at a minimum static-air-pressure difference of 6.24 lbf/sq. ft. (300 Pa).

F. Water Penetration under Static Pressure: Provide aluminum-framed systems that do not evidence water penetration through fixed glazing and framing areas when tested according to ASTM E 331 at a minimum static-air-pressure difference of 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft. (300 Pa).
1. Maximum Water Leakage: No uncontrolled water penetrating aluminum-framed systems or water appearing on systems' normally exposed interior surfaces from sources other than condensation. Water leakage does not include water controlled by flashing and gutters that is drained to exterior and water that cannot damage adjacent materials or finishes.

G. Thermal Movements: Provide aluminum-framed systems that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
2. Interior Ambient-Air Temperature: 75 deg F (24 deg C).

H. Condensation Resistance: Provide aluminum-framed systems with fixed glazing and framing areas having condensation-resistance factor (CRF) of not less than 53 when tested according to AAMA 1503.

I. Thermal Conductance: Provide aluminum-framed systems with fixed glazing and framing areas having an average U-factor of not more than 0.69 Btu/sq. ft. x h x deg F (3.92 W/sq. m x K) when tested according to AAMA 1503.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for aluminum-framed systems.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Shop Drawings: For aluminum-framed systems. Include plans, elevations, sections, details, and attachments to other work.
   1. Include details of provisions for system expansion and contraction and for drainage of moisture in the system to the exterior.

C. Samples for Initial Selection: For units with factory-applied color finishes.

D. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes.

E. Qualification Data: For qualified installer.

F. Welding certificates.

G. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for aluminum-framed systems, indicating compliance with performance requirements.

H. Source quality-control reports.

I. Maintenance Data: For aluminum-framed systems to include in maintenance manuals.

J. Warranties: Sample of special warranties.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

B. Engineering Responsibility: Prepare data for aluminum-framed systems, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in systems similar to those indicated for this Project.

C. Product Options: Information on Drawings and in Specifications establishes requirements for systems' aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction. Performance characteristics are indicated by criteria subject to verification by one or more methods including preconstruction testing, field testing, and in-service performance.
   1. Do not revise intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If revisions are proposed, submit comprehensive explanatory data to Architect for review.

1.7 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of structural supports for aluminum-framed systems by field measurements before fabrication and indicate measurements on Shop Drawings.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of aluminum-framed systems that do not comply with requirements or that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Structural failures including, but not limited to, excessive deflection.
      b. Noise or vibration caused by thermal movements.
      c. Deterioration of metals and other materials beyond normal weathering.
      d. Adhesive or cohesive sealant failures.
      e. Water leakage through fixed glazing and framing areas.
      f. Failure of operating components.
   2. Warranty Period: Two years from date of Substantial Completion.

B. Special Finish Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components on which finishes do not comply with requirements or that fail in materials or workmanship within specified warranty period. Warranty does not include normal weathering.
   1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide YKK AP Series YES 45 TU or approved equal, to match existing.

2.2 MATERIALS

A. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
   1. Sheet and Plate: ASTM B 209 (ASTM B 209M).
   2. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221 (ASTM B 221M).
   3. Extruded Structural Pipe and Tubes: ASTM B 429.
   4. Structural Profiles: ASTM B 308/B 308M.
   5. Welding Rods and Bare Electrodes: AWS A5.10/A5.10M.

B. Steel Reinforcement: Manufacturer's standard zinc-rich, corrosion-resistant primer complying with SSPC-PS Guide No. 12.00 applied immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM and prepare surfaces according to applicable SSPC standard.
   1. Structural Shapes, Plates, and Bars: ASTM A 36/A 36M.
   2. Cold-Rolled Sheet and Strip: ASTM A 1008/A 1008M.
   3. Hot-Rolled Sheet and Strip: ASTM A 1011/A 1011M.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2.3 FRAMING SYSTEMS

A. Framing Members: Manufacturer's standard extruded-aluminum framing members of thickness required and reinforced as required to support imposed loads.
   1. Construction: Thermally broken.
   2. Glazing System: Retained mechanically with gaskets on four sides.
   3. Glazing Plane: Center.

B. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.

C. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.
   1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
   2. Reinforce members as required to receive fastener threads.
   3. Use exposed fasteners with countersunk Phillips screw heads, fabricated from stainless steel.

D. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts, complying with ASTM A 123/A 123M or ASTM A 153/A 153M.

E. Concealed Flashing: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials of type recommended by manufacturer.

F. Framing System Gaskets and Sealants: Manufacturer's standard recommended by manufacturer for joint type.

2.4 GLAZING SYSTEMS

A. Glazing: As specified in Division 08 Section "Glazing."

B. Glazing Gaskets: Manufacturer's standard compression types; replaceable, molded or extruded, of profile and hardness required to maintain watertight seal.

C. Spacers and Setting Blocks: Manufacturer's standard elastomeric type.

2.5 ACCESSORY MATERIALS

A. Joint Sealants: For installation at perimeter of aluminum-framed systems, as specified in Division 07 Section "Joint Sealants."

B. Bituminous Paint: Cold-applied asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos, formulated for 30-mil (0.762-mm) thickness per coat.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2.6 FABRICATION

A. Form or extrude aluminum shapes before finishing.

B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

C. Framing Members, General: Fabricate components that, when assembled, have the following characteristics:
   1. Profiles that are sharp, straight, and free of defects or deformations.
   2. Accurately fitted joints with ends coped or mitered.
   3. Means to drain water passing joints, condensation within framing members, and moisture migrating within the system to exterior.
   4. Physical and thermal isolation of glazing from framing members.
   5. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
   6. Provisions for field replacement of glazing from interior.
   7. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.

D. Mechanically Glazed Framing Members: Fabricate for flush glazing without projecting stops.

E. Structural-Sealant-Glazed Framing Members: Include accommodations for using temporary support device to retain glazing in place while structural sealant cures.

F. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

2.7 ALUMINUM FINISHES

A. High-Performance Organic Finish: 3-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   1. Color and Gloss: Match existing Sludge Processing Building.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3.2 INSTALLATION

A. General:
   1. Comply with manufacturer's written instructions.
   2. Do not install damaged components.
   3. Fit joints to produce hairline joints free of burrs and distortion.
   4. Rigidly secure nonmovement joints.
   5. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration.
   6. Seal joints watertight unless otherwise indicated.

B. Metal Protection:
   1. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or applying sealant or tape, or by installing nonconductive spacers as recommended by manufacturer for this purpose.
   2. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

C. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within the system to exterior.

D. Set continuous sill members and flashing in full sealant bed as specified in Division 07 Section "Joint Sealants" to produce weathertight installation.

E. Install components plumb and true in alignment with established lines and grades, and without warp or rack.

F. Install glazing as specified in Division 08 Section "Glazing."
   1. Structural-Sealant Glazing:
      a. Prepare surfaces that will contact structural sealant according to sealant manufacturer's written instructions to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces.
      b. Install weatherseal sealant according to Division 07 Section "Joint Sealants" and according to sealant manufacturer's written instructions to produce weatherproof joints. Install joint filler behind sealant as recommended by sealant manufacturer.

G. Install perimeter joint sealants as specified in Division 07 Section "Joint Sealants" to produce weathertight installation.

3.3 ERECTION TOLERANCES

A. Install aluminum-framed systems to comply with the following maximum erection tolerances:
   1. Location and Plane: Limit variation from true location and plane to 1/8 inch in 12 feet (3 mm in 3.7 m); 1/4 inch (6 mm) over total length.
   2. Alignment:
      a. Where surfaces abut in line, limit offset from true alignment to 1/16 inch (1.5 mm).
      b. Where surfaces meet at corners, limit offset from true alignment to 1/32 inch (0.8 mm).

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Diagonal Measurements: Limit difference between diagonal measurements to 1/8 inch (3 mm).

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Commercial door hardware for the following:
      a. Swinging doors.
   2. Cylinders for doors specified in other Sections.
   3. Electrical door hardware.

B. Related Sections include the following:
   1. Division 08 Section "Fiberglass Reinforced (FRP) Doors and Frames" for door hardware provided as part of Fiberglass Reinforced (FRP) Doors and Frames.
   2. Division 08 Section "Overhead Coiling Doors" for door hardware provided as part of overhead door assemblies.

C. Products furnished, but not installed, under this Section include the following. Coordinating, purchasing, delivering, and scheduling remain requirements of this Section.
   1. Cylinders for locks specified in other Sections.

1.3 SUBMITTALS

A. Product Data: Include construction and installation details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: Details of electrified door hardware, indicating the following:
   1. Wiring Diagrams: Prepared by electrical hardware manufacturer. Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring. Include the following:
      a. System schematics.
      b. Point-to-point wiring diagram.
      c. Riser diagram.
      d. Elevation of each door.
   2. Submit factory wiring diagram with door hardware submittals.
   3. Detail interface between electrified door hardware, access control, and security system.

C. Samples for Initial Selection: For each finish, color, and texture required for each type of door hardware indicated.

D. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for locks, latches, and closers.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

E. Maintenance Data: For each type of door hardware to include in maintenance manuals. Include final hardware and keying schedule.

F. Warranty: Special warranty specified in this Section.

G. Other Action Submittals:
   1. Door Hardware Sets: In DHI format, prepared by or under the supervision of Installer, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final door hardware sets with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
      a. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule." Double space entries, and number and date each page.
      b. Content: Include the following information:
         1) Identification number, location, hand, fire rating, and material of each door and frame.
         2) Type, style, function, size, quantity, and finish of each door hardware item. Include description and function of each lockset and exit device.
         3) Complete designations of every item required for each door or opening including name and manufacturer.
         4) Fastenings and other pertinent information.
         5) Location of each door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
         6) Explanation of abbreviations, symbols, and codes contained in schedule.
         7) Mounting locations for door hardware.
         8) Door and frame sizes and materials.
         9) Description of each electrified door hardware function, including location, sequence of operation, and interface with other building control systems.
      c. Submittal Sequence: Submit the final door hardware sets at earliest possible date, particularly where approval of the door hardware sets must precede fabrication of other work that is critical in Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the door hardware sets.
   2. Keying Schedule: Prepared by or under the supervision of Installer, detailing Owner's final keying instructions for locks. Include schematic keying diagram and index each key set to unique door designations.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: An employer of factory-trained workers and approved by lock manufacturer.
   1. Installer's responsibilities include supplying and installing door hardware and providing a qualified Architectural Hardware Consultant available during the course of the Work to consult with Contractor, Architect, and Owner about door hardware and keying.
   2. Installer shall have warehousing facilities in Project's vicinity.
   3. Scheduling Responsibility: Preparation of door hardware and keying schedules.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Architectural Hardware Consultant Qualifications: A person who is currently certified by DHI as an Architectural Hardware Consultant and who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project.

C. Source Limitations: Obtain each type and variety of door hardware from a single manufacturer, unless otherwise indicated.
   1. Provide electrified door hardware from same manufacturer as mechanical door hardware.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Inventory door hardware on receipt and provide secure lock-up for door hardware delivered to Project site.

B. Tag each item or package separately with identification related to the final door hardware sets, and include basic installation instructions, templates, and necessary fasteners with each item or package.

C. Deliver keys to manufacturer of key control system for subsequent delivery to Owner.

1.6 COORDINATION

A. Coordinate layout and installation of recessed pivots and closers with floor construction. Cast anchoring inserts into concrete. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Templates: Distribute door hardware templates for doors, frames, and other work specified to be factory prepared for installing door hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.

C. Electrical Systems Roughing-In: Coordinate layout and installation of electrified door hardware with connections to access control system.

D. Existing Openings: Where new hardware components are scheduled for application to existing construction or where modifications to existing door hardware are required, field verify existing conditions and coordinate installation of door hardware to suit opening conditions and to provide for proper operation.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Structural failures including excessive deflection, cracking, or breakage.
      b. Faulty operation of operators and door hardware.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.

2. Warranty Period: Three years from date of Substantial Completion, except as follows:
   a. Exit Devices: Two years from date of Substantial Completion.
   b. Manual Closers: 10 years from date of Substantial Completion.

1.8 MAINTENANCE SERVICE

A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

PART 2 - PRODUCTS

2.1 SCHEDULED DOOR HARDWARE

A. General: Provide door hardware for each door to comply with requirements in this Section and door hardware sets indicated in Part 3 "Door Hardware Sets" Article.
   1. Door Hardware Sets: Provide quantity, item, size, finish or color indicated, and products equivalent in function and comparable in quality to named products.

B. Designations: Requirements for design, grade, function, finish, size, and other distinctive qualities of each type of door hardware are indicated in Part 3 "Door Hardware Sets" Article. Products are identified by using door hardware designations, as follows:
   1. Named Manufacturers' Products: Manufacturer and product designation are listed for each door hardware type required for the purpose of establishing minimum requirements. Manufacturers' names are abbreviated in Part 3 "Door Hardware Sets" Article.

2.2 HINGES, GENERAL

A. Quantity: Provide the following, unless otherwise indicated:
   1. Two Hinges: For doors with heights up to 60 inches (1524 mm).
   2. Three Hinges: For doors with heights 61 to 90 inches (1549 to 2286 mm).
   3. Four Hinges: For doors with heights 91 to 120 inches (2311 to 3048 mm).
   4. For doors with heights more than 120 inches (3048 mm), provide 4 hinges, plus 1 hinge for every 30 inches (750 mm) of door height greater than 120 inches (3048 mm).

B. Size: Provide the following, unless otherwise indicated, with hinge widths sized for door thickness and clearances required:

		Metal Thickness (inches)	
Maximum Door Size (inches)	Hinge Height (inches)	Standard Weight	Heavy Weight
36 by 84 by 1-3/4	4-1/2	0.134	0.180
42 by 90 by 1-3/4	5	----	0.190
48 by 120 by 1-3/4	5	----	0.190

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

C. Template Requirements: Except for hinges and pivots to be installed entirely (both leaves) into wood doors and frames, provide only template-produced units.

D. Hinge Weight: Unless otherwise indicated, provide the following:
1. Exterior Doors: Heavy-weight ball-bearing hinges.
2. Doors with Closers: Heavy-weight ball bearing hinges.
3. Interior Doors: Standard-weight hinges, except where otherwise indicated in hardware sets and size table above.

E. Hinge Base Metal: Unless otherwise indicated, provide the following:
1. Exterior Hinges: Stainless steel, with stainless-steel pin non-removable.
2. Interior Hinges: Brass, with stainless-steel pin body and brass protruding heads or Steel, with brass pin.
3. Hinges for Fire-Rated Assemblies: Steel, with steel pin except, at wet locations provide Stainless steel, with stainless-steel pin.

F. Hinge Options: Where indicated in door hardware sets:
1. Maximum Security Pin: Fix pin in hinge barrel after it is inserted.
2. Nonremovable Pins: Provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for outswinging exterior doors, doors with access control hardware, and outswinging corridor doors with locks.
3. Corners: Square.

G. Fasteners: Comply with the following:
1. Use only fasteners supplied by hardware manufacturer.
2. Machine Screws: For metal doors and frames. Install into drilled and tapped holes.

2.3 HINGES

A. Butts and Hinges: BHMA A156.1.

B. Template Hinge Dimensions: BHMA A156.7.

C. Manufacturers:
1. Hager Companies (HAG).
2. Lawrence Brothers, Inc. (LB).
3. McKinney Products Company; an ASSA ABLOY Group company (MCK).
4. Stanley Commercial Hardware; Div. of The Stanley Works (STH).
5. Or approved equal.

2.4 LOCKS AND LATCHES, GENERAL

A. Accessibility Requirements: Where indicated to comply with accessibility requirements, comply with the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)."
1. Provide operating devices that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than 5 lbf (22 N).

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Latches and Locks for Means of Egress Doors: Comply with NFPA 101. Latches shall not require more than 15 lbf (67 N) to release the latch. Locks shall not require use of a key, tool, or special knowledge for operation.

C. Electrified Locking Devices: BHMA A156.25.

D. Lock Trim:
   1. Levers: Cast.
   2. Provide knurled levers for all openings into hazardous areas, including but not limited to electrical and mechanical rooms, janitors closets, and elevator machine rooms.
   3. Escutcheons (Roses): Cast.
   4. Dummy Trim: Match lever lock trim and escutcheons.
   5. Lockset Designs: Provide design designated below or, if sets are provided by another manufacturer, provide designs that match those designated.
      a. Mortise Locks:
         1) Sargent 8200 LSL trim design.
         2) Yale 8700 Series, Pacific Beach trim design.
         3) Schlage “L” Series, Sparta trim design.
         4) Or approved equal.

E. Lock Throw: Comply with testing requirements for length of bolts required for labeled fire doors, and as follows:
   1. Mortise Locks: Minimum 3/4-inch (19-mm) latchbolt throw.
   2. Deadbolts: Minimum 1-inch (25-mm) bolt throw.

F. Rabbeted Meeting Doors: Provide special rabbeted front and strike on locksets for rabbeted meeting stiles.

G. Backset: 2-3/4 inches (70 mm), unless otherwise indicated.

H. Strikes: Manufacturer's standard strike with strike box for each latchbolt or lock bolt, with curved lip extended to protect frame, finished to match door hardware set, and as follows:
   1. Strikes for Mortise Locks and Latches: BHMA A156.13.
   2. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.

2.5 MECHANICAL LOCKS AND LATCHES

A. Lock Functions: Function numbers and descriptions indicated in door hardware sets comply with the following:
   1. Mortise Locks: BHMA A156.13.

B. Mortise Locks: Stamped steel case with steel or brass parts; BHMA A156.13, Grade 1; Series 1000.
   1. Manufacturers:
      a. Best Access Systems; Div. of The Stanley Works (BAS).
      b. Corbin Russwin Architectural Hardware; an ASSA ABLOY Group company (CR).
      c. SARGENT Manufacturing Company; an ASSA ABLOY Group company (SGT).

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

d. Schlage Commercial Lock Division; an Ingersoll-Rand Company (SCH).
e. Yale Commercial Locks and Hardware; an ASSA ABLOY Group company (YAL).
f. Or approved equal.

2.6 AUXILIARY LOCKS AND LATCHES

A. Auxiliary Locks: BHMA A156.5, Grade 1 unless Grade 2 is indicated.
1. Manufacturers:
a. Best Access Systems; Div. of The Stanley Works (BAS).
b. Corbin Russwin Architectural Hardware; an ASSA ABLOY Group company (CR).
c. SARGENT Manufacturing Company; an ASSA ABLOY Group company (SGT).
d. Schlage Commercial Lock Division; an Ingersoll-Rand Company (SCH).
e. Yale Commercial Locks and Hardware; an ASSA ABLOY Group company (YAL).
f. Or approved equal.

B. Push-Button Combination Locks: BHMA A156.5, Grade 2 for mortise locks.
1. Manufacturers:
a. Corbin Russwin Architectural Hardware; an ASSA ABLOY Group company (CR).
b. Kaba Ilco Inc. (Simplex); a Kaba Group company (KAB).
c. SARGENT Manufacturing Company; an ASSA ABLOY Group company (SGT).
d. Yale Commercial Locks and Hardware; an ASSA ABLOY Group company (YAL).
e. Or approved equal.

2.7 SELF-CONTAINED ELECTRONIC LOCKS

A. General: Internal, battery-powered, self-contained electronic locks; consisting of complete lockset, motor-driven lock mechanism, and actuating device; enclosed in zinc-dichromate-plated, wrought-steel case. Provide key override, low-battery detection and warning, LED status indicators, and ability to program at the lock; type and function indicated.
1. Type: Mortise.
2. Actuating Device: Magnetic-stripe card reader.
a. Card: Manufacturer's standard.
3. Faceplate Material: Stainless steel.
4. Trim: Match trim specified for mechanical locks.

B. Accessory: Card encoder and software.

C. Manufacturers:
1. Corbin Russwin Architectural Hardware; an ASSA ABLOY Group company (CR).
2. Kaba Ilco Inc. (Simplex); a Kaba Group company (KAB).
3. SARGENT Manufacturing Company; an ASSA ABLOY Group company (SGT).
4. Schlage Commercial Lock Division; an Ingersoll-Rand Company (SCH).
5. Yale Commercial Locks and Hardware; an ASSA ABLOY Group company (YAL).
6. Or approved equal.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2.8 EXIT DEVICES

A. Exit Devices: BHMA A156.3, Grade 1.

B. Accessibility Requirements: Where handles, pulls, latches, locks, and other operating devices are indicated to comply with accessibility requirements, comply with the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)."
   1. Provide operating devices that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than 5 lbf (22 N).

C. Exit Devices for Means of Egress Doors: Comply with NFPA 101. Exit devices shall not require more than 15 lbf (67 N) to release the latch. Locks shall not require use of a key, tool, or special knowledge for operation.

D. Panic Exit Devices: Listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for panic protection, based on testing according to UL 305.

E. Fire Exit Devices: Devices complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire and panic protection, based on testing according to UL 305 and NFPA 252.

F. Outside Trim: Pull with cylinder; material and finish to match locksets, unless otherwise indicated.
   1. Match design for locksets and latchsets, unless otherwise indicated.

G. Through Bolts: For exit devices and trim on metal doors.

2.9 LOCK CYLINDERS

A. Standard Lock Cylinders: BHMA A156.5, Grade 1 unless Grade 2 is indicated.

B. Cylinders: Manufacturer's standard tumbler type, constructed from brass or bronze, stainless steel, or nickel silver, and complying with the following:
   1. Factory keyed.
   2. Number of Pins: Six.
   3. Mortise Type: Threaded cylinders with rings and straight- or clover-type cam.
   4. Rim Type: Cylinders with back plate, flat-type vertical or horizontal tailpiece, and raised trim ring.

C. Permanent Cores: Manufacturer's standard; finish face to match lockset; complying with the following:
   1. Interchangeable Cores: Core insert, removable by use of a special key; usable with other manufacturers' cylinders.

D. Construction Keying: Comply with the following:
   1. Construction Cores: Provide construction cores that are replaceable by permanent cores. Provide 10 construction master keys.
      a. Replace construction cores with permanent cores, as directed by Owner.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

E. Manufacturers:
1. ABLOY Security, Inc.; an ASSA ABLOY Group company (ABL).
2. Arrow USA; an ASSA ABLOY Group company (ARW).
3. ASSA, Inc.; an ASSA ABLOY Group company (ASA).
4. Best Access Systems; Div. of The Stanley Works (BAS).
5. Corbin Russwin Architectural Hardware; an ASSA ABLOY Group company (CR).
6. Falcon Lock; an Ingersoll-Rand Company (FAL).
7. Medeco Security Locks, Inc.; an ASSA ABLOY Group company (MED).
8. SARGENT Manufacturing Company; an ASSA ABLOY Group company (SGT).
9. Schlage Commercial Lock Division; an Ingersoll-Rand Company (SCH).
10. Yale Commercial Locks and Hardware; an ASSA ABLOY Group company (YAL).
11. Or approved equal.

2.10 KEYING

A. Keying System: Factory registered, complying with guidelines in BHMA A156.28, Appendix A. Incorporate decisions made in keying conference, and as follows:
1. Grand Master Key System: Cylinders are operated by a change key, a master key, and a grand master key.
2. Existing System: Master key or grand master key locks to Owner's existing system.
3. Keyed Alike: Key all cylinders to same change key.

B. Keys: Nickel silver.
1. Stamping: Permanently inscribe each key with a visual key control number and include the following notation:
a. Notation: "DO NOT DUPLICATE."
2. Quantity: In addition to one extra key blank for each lock, provide the following:
a. Cylinder Change Keys: Four.
b. Master Keys: Six.
c. Grand Master Keys: Six.
d. Great-Grand Master Keys: Six.

2.11 KEY CONTROL SYSTEM

A. Key Control Cabinet: Existing cabinet to be used.

B. Cross-Index System: Existing system to be used.

C. Key Control System Software: Existing system to be used.

2.12 ELECTRIC STRIKES

A. Standard: BHMA A156.31, Grade 1 unless Grade 2 is indicated.

B. General: Use fail-secure electric strikes with fire-rated devices.

C. Manufacturers:
1. Folger Adam Security Inc.; an ASSA ABLOY Group company (FAS).
2. HES, Inc.; an ASSA ABLOY Group company (HES).

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3. Securitron Magnalock Corp. (SMC).
4. Security Door Controls (SDC).
5. Von Duprin; an Ingersoll-Rand Company (VD).
6. Or approved equal.

2.13 OPERATING TRIM

A. Standard: BHMA A156.6.

B. Materials: Fabricate from stainless steel, unless otherwise indicated.

C. Manufacturers:
1. Forms + Surfaces (FS).
2. Hager Companies (HAG).
3. HEWI, Inc. (HEW)
4. IVES Hardware; an Ingersoll-Rand Company (IVS).
5. Rockwood Manufacturing Company (RM).
6. Trimco (TBM).
7. Or approved equal.

D. Push-Pull Plates: Metal 0.050 inch minimum thickness.

2.14 ACCESSORIES FOR PAIRS OF DOORS

A. Carry-Open Bars: Provide carry-open bars for inactive leaves of pairs of doors unless automatic or self-latching bolts are used.
1. Material: Polished brass or bronze, with strike plate.

B. Astragals:
1. Manufacturers: Provide astragals on pairs of exterior doors and on interior doors indicated to have astragals.
a. Hager Companies (HAG).
b. National Guard Products, Inc. (NGP).
c. Pemko Manufacturing Co., Inc. (PEM).
d. Reese Enterprises, Inc. (RE).
e. Or approved equal.

2.15 CLOSERS

A. Accessibility Requirements: Where handles, pulls, latches, locks, and other operating devices are indicated to comply with accessibility requirements, comply with the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)."
1. Comply with the following maximum opening-force requirements:
a. Interior, Non-Fire-Rated Hinged Doors: 5 lbf (22.2 N) applied perpendicular to door.
b. Fire Doors: Minimum opening force allowable by authorities having jurisdiction.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Door Closers for Means of Egress Doors: Comply with NFPA 101. Door closers shall not require more than 30 lbf (133 N) to set door in motion and not more than 15 lbf (67 N) to open door to minimum required width.

C. Surface Closers: BHMA A156.4, Grade 1 unless Grade 2 is indicated. Provide type of arm required for closer to be located on non-public side of door, unless otherwise indicated.
   1. Manufacturers:
      a. Corbin Russwin Architectural Hardware; an ASSA ABLOY Group company (CR).
      b. LCN Closers; an Ingersoll-Rand Company (LCN).
      c. Norton Door Controls; an ASSA ABLOY Group company (NDC).
      d. Rixson Specialty Door Controls; an ASSA ABLOY Group company (RIX).
      e. SARGENT Manufacturing Company; an ASSA ABLOY Group company (SGT).
      f. Yale Commercial Locks and Hardware; an ASSA ABLOY Group company (YAL).
      g. Or approved equal.

2.16 PROTECTIVE TRIM UNITS

A. Size: 1-1/2 inches (38 mm) less than door width on push side and 1/2 inch (13 mm) less than door width on pull side, by height as follows:
   1. Plates:
      a. Mop plate – 6 inches.
      b. Kick plate – 10 inches.
      c. Armor plate – 36 inches.
   2. Furnish door edgings and corner guards in 36 inch height.

B. Fasteners: Manufacturer's standard machine or self-tapping screws.

C. Metal Protective Trim Units: BHMA A156.6; beveled top and 2 sides; fabricated from the following material:
   1. Material: 0.050-inch (1.3-mm) thick stainless steel.
   2. Manufacturers:
      a. Baldwin Hardware Corporation (BH).
      b. Hager Companies (HAG).
      c. IPC Door and Wall Protection Systems, Inc.; Div. of InPro Corporation (IPC).
      d. IVES Hardware; an Ingersoll-Rand Company (IVS).
      e. McKinney Products Company; an ASSA ABLOY Group company (MCK).
      f. Pawling Corporation (PAW).
      g. Rockwood Manufacturing Company (RM).
      h. Trimco (TBM).
      i. Or approved equal.

2.17 STOPS AND HOLDERS

A. Stops and Bumpers: BHMA A156.16, Grade 1 unless Grade 2 is indicated.

B. Mechanical Door Holders: BHMA A156.16, Grade 1 unless Grade 2 is indicated.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

C. Combination Overhead Stops and Holders: BHMA A156.8, Grade 1 unless Grade 2 is indicated.

D. Silencers for Metal Door Frames: BHMA A156.16, Grade 1; neoprene or rubber, minimum diameter 1/2 inch (13 mm); fabricated for drilled-in application to frame.

E. Manufacturers:
1. Baldwin Hardware Corporation (BH).
2. Glynn-Johnson; an Ingersoll-Rand Company (GJ).
3. Hager Companies (HAG).
4. IVES Hardware; an Ingersoll-Rand Company (IVS).
5. Rixson Specialty Door Controls; an ASSA ABLOY Group company (RIX).
6. Rockwood Manufacturing Company (RM).
7. Trimco (TBM).
8. Or approved equal.

2.18 DOOR GASKETING

A. Standard: BHMA A156.22.

B. General: Provide continuous weather-strip gasketing on exterior doors and provide smoke, light, or sound gasketing on interior doors where indicated or scheduled. Provide noncorrosive fasteners for exterior applications and elsewhere as indicated.
1. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.
2. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.
3. Door Bottoms: Apply to bottom of door, forming seal with threshold when door is closed.

C. Air Leakage: Not to exceed 0.50 cfm per foot (0.000774 cu. m/s per m) of crack length for gasketing other than for smoke control, as tested according to ASTM E 283.

D. Sound-Rated Gasketing: Assemblies listed and labeled by a testing and inspecting agency, for sound ratings indicated, based on testing according to ASTM E 1408.

E. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.

F. Gasketing Materials: ASTM D 2000 and AAMA 701/702.

G. Manufacturers:
1. Hager Companies (HAG).
2. National Guard Products (NGP).
3. Pemko Manufacturing Co. (PEM).
4. Reese Enterprises (RE).
5. Zero International (ZRO).
6. Or approved equal.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2.19 THRESHOLDS

A. Standard: BHMA A156.21.

B. Accessibility Requirements: Where thresholds are indicated to comply with accessibility requirements, comply with the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)."
   1. Bevel raised thresholds with a slope of not more than 1:2. Provide thresholds not more than 1/2 inch (13 mm) high.

C. Thresholds for Means of Egress Doors: Comply with NFPA 101. Maximum 1/2 inch (13 mm) high.

D. Manufacturers:
   1. Hager Companies (HAG).
   2. National Guard Products (NGP).
   3. Pemko Manufacturing Co. (PEM).
   4. Reese Enterprises (RE).
   5. Rixson Specialty Door Controls; an ASSA ABLOY Group company. (RIX).
   6. Zero International (ZRO).
   7. Or approved equal.

2.20 MISCELLANEOUS DOOR HARDWARE

A. Auxiliary Hardware: BHMA A156.16, Grade 1 unless Grade 2 is indicated.
   1. Manufacturers:
      a. Hager Companies (HAG).
      b. Lawrence Brothers, Inc. (LB).
      c. Rockwood Manufacturing Company (RM).
      d. Stanley Commercial Hardware; Div. of The Stanley Works (STH).
      e. Trimco (TBM).
      f. Or approved equal.

2.21 FABRICATION

A. Base Metals: Produce door hardware units of base metal, fabricated by forming method indicated, using manufacturer's standard metal alloy, composition, temper, and hardness. Furnish metals of a quality equal to or greater than that of specified door hardware units and BHMA A156.18. Do not furnish manufacturer's standard materials or forming methods if different from specified standard.

B. Fasteners: Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to commercially recognized industry standards for application intended, except aluminum fasteners are not permitted. Provide Phillips flat-head screws with finished heads to match surface of door hardware, unless otherwise indicated.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1. Concealed Fasteners: For door hardware units that are exposed when door is closed, except for units already specified with concealed fasteners. Do not use through bolts for installation where bolt head or nut on opposite face is exposed unless it is the only means of securely attaching the door hardware. Where through bolts are used on hollow door and frame construction, provide sleeves for each through bolt.
2. Steel Machine or Wood Screws: For the following fire-rated applications:
   a. Mortise hinges to doors.
   b. Strike plates to frames.
   c. Closers to doors and frames.
3. Steel Through Bolts: For the following fire-rated applications, unless door blocking is provided:
   a. Surface hinges to doors.
   b. Closers to doors and frames.
   c. Surface-mounted exit devices.
4. Spacers or Sex Bolts: For through bolting of hollow-metal doors.

2.22 FINISHES

A. Standard: BHMA A156.18, as indicated in door hardware sets.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.

B. Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Doors and Frames: Comply with DHI A115 Series.
   1. Surface-Applied Door Hardware: Drill and tap doors and frames according to ANSI A250.6.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3.3 INSTALLATION

A. Mounting Heights: Mount door hardware units at heights indicated as follows unless otherwise indicated or required to comply with governing regulations.
   1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
   2. Custom Steel Doors and Frames: DHI's "Recommended Locations for Builders' Hardware for Custom Steel Doors and Frames."
   3. Coordinate mounting of panic/exit devices with light opening so that hardware does not cross window.

B. Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 09 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.
   1. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
   2. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.
   3. Use only fasteners supplied by manufacturer.
   4. Do not install exit devices across door window lites.

C. Key Control System: Tag keys and place them on markers and hooks in key control system cabinet, as determined by final keying schedule.

D. Boxed Power Supplies: Locate power supplies as indicated. Verify location with Architect.
   1. Configuration: Provide one power supply for each door opening with electrified door hardware.

E. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 07 Section "Joint Sealants."
   1. Cut and fit threshold and floor covers to profile of door frames, with mitered corners and hairline joints; join units with concealed welds or concealed mechanical joints. Cut smooth openings for spindles, bolts and similar items, if any.
   2. Screw thresholds to substrate with No. 10 or larger screws, of the proper type for permanent anchorage and of bronze or stainless steel which will not corrode in contact with the threshold metal.
   3. On heavy-duty cast metal thresholds, provide not less than 3/8 inch (9mm) diameter screw anchors.
   4. At exterior doors, and elsewhere as indicated, set thresholds in a bed of either butyl rubber sealant or polyisobutylene mastic sealant to completely fill concealed voids and exclude moisture from every source. Do not plug drainage holes or block weeps. Remove excess sealant.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3.4 ADJUSTING

A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended.
   1. Adjust door control devices after start-up of operation of heating and ventilating equipment; comply with referenced accessibility requirements.
   2. Spring Hinges: Adjust to achieve positive latching when door is allowed to close freely from an open position of 30 degrees.
   3. Electric Strikes: Adjust horizontal and vertical alignment of keeper to properly engage lock bolt.
   4. Door Closers: Unless otherwise required by authorities having jurisdiction, adjust sweep period so that, from an open position of 70 degrees, the door will take at least 3 seconds to move to a point 3 inches (75 mm) from the latch, measured to the leading edge of the door.
      a. Adjust all closers to open 90 degrees minimum.

B. Occupancy Adjustment: Approximately six months after date of Substantial Completion, Installer's Architectural Hardware Consultant shall examine and readjust, including adjusting operating forces, each item of door hardware as necessary to ensure function of doors, door hardware, and electrified door hardware.

3.5 CLEANING AND PROTECTION

A. Clean adjacent surfaces soiled by door hardware installation.

B. Clean operating items as necessary to restore proper function and finish.

C. Provide final protection and maintain conditions that ensure that door hardware is without damage or deterioration at time of Substantial Completion.

3.6 DOOR HARDWARE SCHEDULE

A. The attached hardware sets are listed as a guide to requirements. Hardware items are scheduled by model number to establish and quality and operating characteristics. It is the responsibility of the hardware supplier to provide additional hardware in accordance with this Section for the proper function of all doors.

B. Refer to the Door Schedule or Floor Plans for reference to hardware set requirements for each door.

C. Manufacturers:
   1. Hager (1).
   2. Schlage (2).
   3. LCN (3).
   4. Von Duprin (4).
   5. Stanley (5).
   6. H. B. Ives (6).

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

D. Furnish Hager Silencers, 307D, three per single door and two per pair of doors.

E. Mount closers parallel arm on outswinging doors.

3.7 HARDWARE SETS

SET 1
ALL HARDWARE BY DOOR VENDOR

SET 2
Each to receive:

3	HINGES BB1191-32, 4-1/2" x 4-1/2"	(1)
1	LOCKSET L9080TEU 17A 625	(2)
1	PERMANENT CORE 23-030 626	(2)
1	CLOSER 4041 SCUSH SNB AL	(3)
1	STOP	(6)
1	THRESHOLD 520SN, 1/4" x 5" x 36" AL	(1)
1	SET WEATHERSTRIP 891 SV 3080 AL	(1)
1	DRIP CAP 8105 40" AL	(1)

SET 3
Each to receive:

3	HINGES BB1191-32, 4-1/2" x 4-1/2"	(1)
1	HINGE BB1191-32, 4-1/2" x 4-1/2"	(1)
1	EXIT DEVICE 99NL FX 9961 SNB US26	(4)
1	CYLINDER 20-079 625	(2)
1	CONSTRUCTION CORE 23-030 626 1CX	(2)
1	PERMANENT CORE 23-030 626	(2)
1	CLOSER 4041 SCUSH SNB AL	(3)
1	STOP	(6)
1	THRESHOLD 520 SN 1/4" x 5" x 36" AL	(1)
1	SET WEATHERSTRIP 891 SV 3080 AL	(1)
1	DRIP CAP 8105 40" AL	(1)
	CARD READER BY SECURITY VENDOR	

SET 4
Each to receive:

8	HINGES BB1191-31, 4-1/2" x 4-1/2"	(1)
1	HINGE BB1191-32, 4-1/2" x 4-1/2" ETW4	(1)
2	EXIT DEVICES 99NL FX 9961 SNB US26	(4)
2	FLUSH BOLTS 458B 26-1/12" 1/24"	(6)
2	CLOSERS 4041 SCUSH SNB AL	(3)
1	THRESHOLD 520 SN 1/4" x 5" x 72" AL	(1)
1	SET WEATHERSTRIP 891 SV 6080 AL	(1)
1	DRIP CAP 8105 80" AL	(1)
	CARD READER BY SECURITY VENDOR	

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

SET 5
Each to receive:

8	HINGES BB1191-31, 4-1/2" x 4-1/2"	(1)
2	EXIT DEVICES 99NL FX 9961 SNB US26	(4)
2	FLUSH BOLTS 458B 26-1/12" 1/24"	(6)
2	CLOSERS 4041 SCUSH SNB AL	(3)
1	THRESHOLD 520 SN 1/4" x 5" x 72" AL	(1)
1	SET WEATHERSTRIP 891 SV 6080 AL	(1)
1	DRIP CAP 8105 80" AL	(1)

SET 6
Each to receive:

3	HINGES BB1191-32, 4-1/2" X 4-1/2"	(1)
1	LOCKSET L9080T 17A 625	(2)
1	PERMANENT CORE 23-030 626	(2)
1	CLOSER 1461 SNB AL	(3)
1	STOP	(6)

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes glazing for the following products and applications, including those specified in other Sections where glazing requirements are specified by reference to this Section:
   1. Windows.
   2. Doors.

B. Related Sections:
   1. Division 08 Section "Fiberglass Reinforced (FRP) Doors and Frames".

1.3 DEFINITIONS

A. Glass Manufacturers: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.

B. Glass Thicknesses: Indicated by thickness designations in millimeters according to ASTM C 1036.

C. Interspace: Space between lites of an insulating-glass unit.

1.4 PERFORMANCE REQUIREMENTS

A. General: Installed glazing systems shall withstand normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, or installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.

B. Delegated Design: Design glass, including comprehensive engineering analysis according to ASTM E 1300 by a qualified Professional Engineer, using the following design criteria:
   1. Design Wind Pressures: Not less than wind loads applicable to the Project as required by ASCE 7 “Minimum Design Loads for Buildings and Other Structures: Section 6.0, 'Wind Loads'”.
   2. Vertical Glazing: For glass surfaces sloped 15 degrees or less from vertical, design glass to resist design wind pressure based on glass type factors for short-duration load.
   3. Maximum Lateral Deflection: For glass supported on all four edges, limit center-of-glass deflection at design wind pressure to not more than 1/50 times the short-side length or 1 inch (25 mm), whichever is less.

C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on glass framing members and glazing components.
   1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1.5 SUBMITTALS

A. Product Data: For each glass product and glazing material indicated.

B. Glass Samples: For each type of the following products; 12 inches (300 mm) square.
   1. Tinted glass.
   2. Fire-resistive glazing products.
   3. Insulating glass.
   4. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.

C. Qualification Data: For installers.

D. Product Certificates: For glass and glazing products, from manufacturer.

E. Preconstruction adhesion and compatibility test report.

F. Warranties: Sample of special warranties.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications for Insulating-Glass Units with Sputter-Coated, Low-E Coatings: A qualified insulating-glass manufacturer who is approved by coated-glass manufacturer.

B. Installer Qualifications: A qualified installer who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.

C. Source Limitations for Glass: Obtain float glass and insulating glass from single source from single manufacturer for each glass type.

D. Source Limitations for Glazing Accessories: Obtain from single source from single manufacturer for each product and installation method.

E. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below, unless more stringent requirements are indicated. Refer to these publications for glazing terms not otherwise defined in this Section or in referenced standards.

F. Safety Glazing Labeling: Where safety glazing labeling is indicated, permanently mark glazing with certification label of the SGCC or another certification agency acceptable to authorities having jurisdiction or the manufacturer. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.

G. Fire-Protection-Rated Glazing Labeling: Permanently mark fire-protection-rated glazing with certification label of a testing agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name, test standard, whether glazing is for use in fire doors or other openings, whether or not glazing passes hose-stream test, whether or not glazing has a temperature rise rating of 450 deg F (250 deg C), and the fire-resistance rating in minutes.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

H. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of IGCC.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Protect glazing materials according to manufacturer's written instructions. Prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.

B. Comply with insulating-glass manufacturer's written recommendations for venting and sealing units to avoid hermetic seal ruptures due to altitude change.

1.8 PROJECT CONDITIONS

A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.
   1. Do not install glazing sealants when ambient and substrate temperature conditions are outside limits permitted by sealant manufacturer or below 40 deg F (4.4 deg C).

1.9 WARRANTY

A. Manufacturer's Special Warranty on Insulating Glass: Manufacturer's standard form in which insulating-glass manufacturer agrees to replace insulating-glass units that deteriorate within specified warranty period. Deterioration of insulating glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.
   1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GLASS PRODUCTS, GENERAL

A. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass lites in thicknesses as needed to comply with requirements indicated.

B. Strength: Where float glass is indicated, provide annealed float glass, Kind HS heat-treated float glass, or Kind FT heat-treated float glass as needed to comply with "Performance Requirements" Article. Where heat-strengthened glass is indicated, provide Kind HS heat-treated float glass or Kind FT heat-treated float glass as needed to comply with "Performance Requirements" Article. Where fully tempered glass is indicated, provide Kind FT heat-treated float glass.

C. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:
   1. For monolithic-glass lites, properties are based on units with lites 6.0 mm (1/4 inch) thick.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2. For insulating-glass units, properties are based on units of thickness indicated for overall unit and for each lite.
3. U-Factors: Center-of-glazing values, according to NFRC 100 and based on LBL's WINDOW 5.2 computer program, expressed as Btu/sq. ft. x h x deg F (W/sq. m x K).
4. Solar Heat-Gain Coefficient and Visible Transmittance: Center-of-glazing values, according to NFRC 200 and based on LBL's WINDOW 5.2 computer program.
5. Visible Reflectance: Center-of-glazing values, according to NFRC 300.

2.2 GLASS PRODUCTS

A. Ultraclear Float Glass: ASTM C 1036, Type I, Quality-Q3, Class I, complying with other requirements specified and with visible light transmission not less than 91 percent and solar heat gain coefficient not less than 0.87.
   1. Products: Subject to compliance with requirements, provide one of the following; or approved equal.
      a. AFG Flat Glass North America; Krystal Klear.
      b. Guardian Industries Corp.; Ultrawhite.
      c. Pilkington North America; Optiwhite.
      d. PPG Industries, Inc.; Starphire.

2.3 FIRE-PROTECTION-RATED GLAZING

A. Fire-Protection-Rated Glazing, General: Listed and labeled by a testing agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 257 for window assemblies.

B. Monolithic Ceramic Glazing: Clear, ceramic flat glass; 3/16-inch (5-mm) nominal thickness.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Nippon Electric Glass Co., Ltd. (distributed by Technical Glass Products); Premium FireLite.
      b. Schott North America, Inc.; Pyran Crystal.
      c. Vetrotech Saint-Gobain; SGG Keralite FR-R.

C. Film-Faced Ceramic Glazing: Clear, ceramic flat glass; 3/16-inch (5-mm) nominal thickness; faced on one surface with a clear glazing film; complying with testing requirements in 16 CFR 1201 for Category II materials.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Nippon Electric Glass Co., Ltd. (distributed by Technical Glass Products); Premium FireLite NT.
      b. Schott North America, Inc.; Filmed Pyran Crystal F.
      c. Vetrotech Saint-Gobain; SGG Keralite FR-F.

D. Laminated Ceramic Glazing: Laminated glass made from 2 plies of clear, ceramic flat glass; 5/16-inch (8-mm) total nominal thickness; complying with testing requirements in 16 CFR 1201 for Category II materials.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Nippon Electric Glass Co., Ltd. (distributed by Technical Glass Products); FireLite Plus.
      b. Schott North America, Inc.; Laminated Pyran Crystal.
      c. Vetrotech Saint-Gobain; SGG Keralite FR-L.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

E. Laminated Glass with Intumescent Interlayers: Laminated glass made from multiple plies of uncoated, clear float glass; with intumescent interlayers; complying with testing requirements in 16 CFR 1201 for Category II materials.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. InterEdge, Inc., a subsidiary of AFG Flat Glass North America; Pyrobel.
      b. Pilkington Group Limited (distributed by Technical Glass Products); PyroStop.
      c. Vetrotech Saint-Gobain; SGG Swissflam N2.

F. Gel-Filled, Double Glazing Units: Double glazing units made from two lites of uncoated, clear, fully tempered float glass; with a perimeter metal spacer separating lites and dual-edge seal enclosing a cavity filled with clear, fully transparent, heat-absorbing gel; complying with testing requirements in 16 CFR 1201 for Category II materials.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Safti First; SuperLite II-XL.
      b. Vetrotech Saint-Gobain; Contraflam N2.

2.4 INSULATING GLASS

A. Insulating-Glass Units: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified according to ASTM E 2190, and complying with other requirements specified.
   1. Sealing System: Dual seal, with polyisobutylene and silicone primary and secondary.
   2. Spacer: Manufacturer's standard spacer material and construction.
   3. Desiccant: Molecular sieve or silica gel, or blend of both.

B. Glass: Comply with applicable requirements in "Glass Products" Article as indicated by designations in "Insulating-Glass Types" Article and in "Insulating-Laminated-Glass Types" Article.

2.5 GLAZING GASKETS

A. Dense Compression Gaskets: Molded or extruded gaskets of profile and hardness required to maintain watertight seal, made from one of the following:
   1. EPDM complying with ASTM C 864.
   2. Silicone complying with ASTM C 1115.
   3. Thermoplastic polyolefin rubber complying with ASTM C 1115.

B. Soft Compression Gaskets: Extruded or molded, closed-cell, integral-skinned EPDM silicone or thermoplastic polyolefin rubber gaskets complying with ASTM C 509, Type II, black; of profile and hardness required to maintain watertight seal.
   1. Application: Use where soft compression gaskets will be compressed by inserting dense compression gaskets on opposite side of glazing or pressure applied by means of pressure-glazing stops on opposite side of glazing.

2.6 GLAZING SEALANTS

A. General:
   1. Compatibility: Provide glazing sealants that are compatible with one another and with other materials they will contact, including glass products, seals of insulating-glass

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.

2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
3. Colors of Exposed Glazing Sealants: As selected by Architect from manufacturer's full range

B. Glazing Sealant: Neutral-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 50, Use NT.
   1. Products: Subject to compliance with requirements, provide one of the following; or approved equal.
      a. BASF Building Systems; Omniseal 50.
      b. Dow Corning Corporation; 795 or 995.
      c. GE Advanced Materials - Silicones; SilPruf NB SCS9000 or UltraPruf II SCS2900.
      d. Pecora Corporation; 895NST or 898.
   2. Applications: Structural and nonstructural glazing of glass, metal and plastic.

C. Glazing Sealant: Neutral-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 25, Use NT.
   1. Products: Subject to compliance with requirements, provide one of the following; or approved equal.
      a. Dow Corning Corporation; 799.
      b. GE Advanced Materials - Silicones; UltraGlaze SSG4000Ultra or Glaze SSG4000AC.
      c. Polymeric Systems, Inc.; PSI-631.
      d. Schnee-Morehead, Inc., an ITW company; SM5731 Poly-Glaze Plus.
      e. Tremco Incorporated; Proglaze SSG or Tremsil 600.
   2. Applications: Structural and nonstructural, factory or field glazing of glass and metal.

D. Glazing Sealants for Fire-Rated Glazing Products: Products that are approved by testing agencies that listed and labeled fire-resistant glazing products with which they are used for applications and fire-protection ratings indicated.

2.7 GLAZING TAPES

A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; and complying with ASTM C 1281 and AAMA 800 for products indicated below:
   1. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
   2. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.

B. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; and complying with AAMA 800 for the following types:
   1. AAMA 810.1, Type 1, for glazing applications in which tape acts as the primary sealant.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2. AAMA 810.1, Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

2.8 MISCELLANEOUS GLAZING MATERIALS

A. General: Provide products of material, size, and shape complying with referenced glazing standard, requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.

B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.

C. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.

D. Spacers: Elastomeric blocks or continuous extrusions of hardness required by glass manufacturer to maintain glass lites in place for installation indicated.

E. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).

F. Cylindrical Glazing Sealant Backing: ASTM C 1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.

G. Perimeter Insulation for Fire-Resistive Glazing: Product that is approved by testing agency that listed and labeled fire-resistant glazing product with which it is used for application and fire-protection rating indicated.

2.9 FABRICATION OF GLAZING UNITS

A. Fabricate glazing units in sizes required to fit openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.

2.10 MONOLITHIC GLASS TYPES

A. Glass Type MA-1: Clear fully tempered float glass.
1. Thickness: 1/4-inch (6.0 mm).
2. Provide safety glazing labeling.

2.11 INSULATING-GLASS TYPES

A. Glass Type GL-1: Low-E-coated, tinted insulating glass.
1. Overall Unit Thickness: 1 inch (25 mm).
2. Thickness of Each Glass Lite: 6.0 mm (1/4 inch).
3. Outdoor Lite: Tinted heat-strengthened float glass.
4. Interspace Content: Air.
5. Indoor Lite: Clear heat-strengthened float glass.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

6. Low-E-Coating: Sputtered on thick surface.
7. Visible Light Transmittance: 34 percent minimum.
8. Winter Nighttime U-Factor: .28 maximum.
9. Summer Daytime U-Factor: .32 maximum.
10. Solar Heat Gain Coefficient: .31 maximum.
11. Outdoor Visible Reflectance: 7 percent maximum.

2.12 FIRE-PROTECTION-RATED GLAZING TYPES

A. Glass Type GL-2: 45-minute fire-rated glazing; laminated glass with intumescent interlayers or gel-filled, double glazing units.
   1. Provide safety glazing labeling.
   2. Frame Assembly: Manufacturer's tested frame assembly to meet required rating.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine framing, glazing channels, and stops, with Installer present, for compliance with the following:
   1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
   2. Presence and functioning of weep system.
   3. Minimum required face and edge clearances.
   4. Effective sealing between joints of glass-framing members.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.

B. Examine glazing units to locate exterior and interior surfaces. Label or mark units as needed so that exterior and interior surfaces are readily identifiable. Do not use materials that will leave visible marks in the completed work.

3.3 GLAZING, GENERAL

A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.

B. Adjust glazing channel dimensions as required by Project conditions during installation to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

C. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass is glass with edge damage or other imperfections that, when installed, could weaken glass and impair performance and appearance.

D. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.

E. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.

F. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.

G. Provide spacers for glass lites where length plus width is larger than 50 inches (1270 mm).
   1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
   2. Provide 1/8-inch (3-mm) minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.

H. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.

I. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.

J. Set glass lites with proper orientation so that coatings face exterior or interior as specified.

K. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.

L. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

3.4 GASKET GLAZING (DRY)

A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.

B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

C. Installation with Drive-in Wedge Gaskets: Center glass lites in openings on setting blocks and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

D. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

E. Install gaskets so they protrude past face of glazing stops.

3.5 CLEANING AND PROTECTION

A. Protect exterior glass from damage immediately after installation by attaching crossed streamers to framing held away from glass. Do not apply markers to glass surface. Remove nonpermanent labels and clean surfaces.

B. Protect glass from contact with contaminating substances resulting from construction operations. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by glass manufacturer.

C. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains; remove as recommended in writing by glass manufacturer.

D. Remove and replace glass that is broken, chipped, cracked, or abraded or that is damaged from natural causes, accidents, and vandalism, during construction period.

E. Wash glass on both exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended in writing by glass manufacturer.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Fixed, extruded-aluminum louvers.

B. Related Sections include the following:
   1. Division 23 Sections for louvers that are a part of mechanical equipment.

1.3 DEFINITIONS

A. Louver Terminology: Definitions of terms for metal louvers contained in AMCA 501 apply to this Section unless otherwise defined in this Section or in referenced standards.

B. Drainable-Blade Louver: Louver with blades having gutters that collect water and drain it to channels in jambs and mullions, which carry it to bottom of unit and away from opening.

1.4 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide louvers capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of louver components, noise or metal fatigue caused by louver blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures shall be considered to act on vertical projection of louvers.
   1. Wind Loads: Determine loads based on pressures as indicated on Drawings.

B. Air-Performance, Water-Penetration, Air-Leakage, and Wind-Driven Rain Ratings: Provide louvers complying with performance requirements indicated, as demonstrated by testing manufacturer's stock units identical to those provided, except for length and width according to AMCA 500-L.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated. For louvers specified to bear AMCA seal, include printed catalog pages showing specified models with appropriate AMCA Certified Ratings Seals.

B. Shop Drawings: For louvers and accessories. Include plans, elevations, sections, details, and attachments to other Work. Show blade profiles, angles, and spacing.

C. Samples for Initial Selection: For units with factory-applied color finishes.

D. Samples for Verification: For each type of metal finish required.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

E. Qualification Data: For professional engineer.

F. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency or by manufacturer and witnessed by a qualified testing agency, for each type of louver.

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain louvers and vents through one source from a single manufacturer where indicated to be of same type, design, or factory-applied color finish.

B. Welding: Qualify procedures and personnel according to the following:
   1. AWS D1.2, "Structural Welding Code--Aluminum."

C. UL and NEMA Compliance: Provide motors and related components for motor-operated adjustable louvers that are listed and labeled by UL and comply with applicable NEMA standards.

1.7 PROJECT CONDITIONS

A. Field Measurements: Verify louver openings by field measurements before fabrication and indicate measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following; or approved equal.
   1. Louvers:
      a. Airline Louvers, A Nystrom Building Products Company, www.nystrom.com.
      b. Airolite Company (The), www.airolite.com.
      c. American Warming and Ventilating, Inc., www.wcnet.org/~awv/
      d. C/S Group Construction Specialties, Inc., www.c-sgroup.com.
      e. Greenheck, www.greenheck.com.
      f. Ruskin Company; www.ruskin.com.

B. In other Part 2 articles where titles below introduce lists, the following requirements apply for product selection:
   1. Products: Subject to compliance with requirements, provide one of the products specified.
   2. Basis-of-Design Product: The design for each louver is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other manufacturers specified.

2.2 MATERIALS

A. Aluminum Extrusions: ASTM B 221(ASTM B 221M), alloy 6063-T5 or T-52.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Aluminum Sheet: ASTM B 209(ASTM B 209M), alloy 3003 or 5005 with temper as required for forming, or as otherwise recommended by metal producer for required finish.

C. Aluminum Castings: ASTM B 26/B 26M, alloy 319.

D. Fasteners: 300 Series stainless steel, unless otherwise indicated. Do not use metals that are incompatible with joined materials.
   1. Use types and sizes to suit unit installation conditions.
   2. Use Phillips flat-head screws for exposed fasteners, unless otherwise indicated.

E. Postinstalled Fasteners for Concrete and Masonry: Torque-controlled expansion anchors, made from stainless-steel components, with capability to sustain, without failure, a load equal to 4 times the loads imposed, for concrete, or 6 times the load imposed, for masonry, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.

F. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.3 FABRICATION, GENERAL

A. Assemble louvers in factory to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

B. Maintain equal louver blade spacing, including separation between blades and frames at head and sill, to produce uniform appearance.

C. Maintain equal louver blade spacing to produce uniform appearance.

D. Fabricate frames, including integral sills, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.
   1. Frame Type: Channel, unless otherwise indicated.

E. Include supports, anchorages, and accessories required for complete assembly.

F. Provide vertical mullions of type and at spacings indicated, but not more than recommended by manufacturer, or 72 inches(1830 mm) o.c., whichever is less.
   1. Exposed Mullions: Where indicated, provide units with exposed mullions of same width and depth as louver frame. Where length of louver exceeds fabrication and handling limitations, provide interlocking split mullions designed to permit expansion and contraction.
   2. Exterior Corners: Manufacturers standard prefabricated corner units.

G. Join frame members to each other and to fixed louver blades with fillet welds concealed from view, unless otherwise indicated or size of louver assembly makes bolted connections between frame members necessary.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2.4 FIXED, EXTRUDED-ALUMINUM LOUVERS

A. Horizontal, Drainable-Blade Louver:
   1. Basis-of-Design Product: C/S Group Construction Specialties, Inc., Model A4157, a comparable product of one of the following, or approved equal.
      a. Greenheck, www.greenheck.com.
      b. Airolite Company, www.airolite.com.
      c. Ruskin Company, www.ruskin.com.
   2. Louver Depth: 4 inches(100 mm).
   3. Frame and Blade Nominal Thickness: As required to comply with structural performance requirements, but not less than 0.080 inch(2.0 mm).
   4. Mullion Type: Exposed.
   5. Performance Requirements:
      a. Free Area: Not less than 7.93 sq. ft.(0.737 m^2) for 48-inch-(1.2-m-) wide by 48-inch-(1.2-m-) high louver.
      b. Point of Beginning Water Penetration: Not less than 950 fpm(4.8 m/s).
      c. Air Performance: Not more than 0.10-inch wg(25-Pa) static pressure drop at 900-fpm(4.5-m/s) free-area velocity.
   6. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

2.5 LOUVER SCREENS

A. General: Provide screen at each exterior louver.
   1. Screen Location for Fixed Louvers: Interior face.
   2. Screening Type: Insect screening.

B. Secure screens to louver frames with stainless-steel machine screws, spaced a maximum of 6 inches(150 mm) from each corner and at 12 inches(300 mm) o.c.

C. Louver Screen Frames: Fabricate with mitered corners to louver sizes indicated.
   1. Metal: Same kind and form of metal as indicated for louver to which screens are attached. Reinforce extruded-aluminum screen frames at corners with clips.
   2. Finish: Same finish as louver frames to which louver screens are attached.
   3. Type: Rewirable frames with a driven spline or insert for securing screen mesh.

D. Louver Screening for Aluminum Louvers:
   1. Insect Screening: Aluminum, 18-by-16(1.4-by-1.6-mm) mesh, 0.012-inch(0.30-mm) wire.

2.6 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Finish louvers after assembly.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2.7 ALUMINUM FINISHES

A. Finish designations prefixed by AA comply with system established by the Aluminum Association for designating aluminum finishes.

B. High-Performance Organic-Coating Finish: AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: acid-chromate-fluoride-phosphate conversion coating; Organic Coating: as specified below). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   1. Fluoropolymer Three-Coat Coating System: Manufacturer's standard three-coat, thermocured system consisting of specially formulated inhibitive primer, fluoropolymer color coat, and clear fluoropolymer topcoat, with both color coat and clear topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight; complying with AAMA 2605.
      a. Color and Gloss: As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and openings, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Coordinate setting drawings, diagrams, templates, instructions, and directions for installation of anchorages that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.

3.3 INSTALLATION

A. Install louvers in accordance with approved shop drawings and manufacturer’s published instructions.

B. Locate and place louvers and vents level, plumb, and at indicated alignment with adjacent work.

C. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.

D. Form closely fitted joints with exposed connections accurately located and secured.

E. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

F. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.

G. Protect galvanized and nonferrous-metal surfaces from corrosion or galvanic action by applying a heavy coating of bituminous paint on surfaces that will be in contact with concrete, masonry, or dissimilar metals.

H. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weathertight louver joints are required. Comply with Division 07 Section "Joint Sealants" for sealants applied during louver installation.

3.4 ADJUSTING AND CLEANING

A. Clean exposed surfaces of louvers and vents that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate until final cleaning.

B. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry.

C. Restore louvers and vents damaged during installation and construction so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Architect, remove damaged units and replace with new units.
   1. Touch up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes acoustical tiles for ceilings and the following:
   1. Concealed suspension systems.

B. Products furnished, but not installed under this Section, include anchors, clips, and other ceiling attachment devices to be cast in concrete at ceilings.

1.3 DEFINITIONS

A. AC: Articulation Class.

B. CAC: Ceiling Attenuation Class.

C. LR: Light-Reflectance coefficient.

D. NRC: Noise Reduction Coefficient.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
   1. Ceiling suspension system members.
   2. Method of attaching hangers to building structure.
      a. Furnish layouts for cast-in-place anchors, clips, and other ceiling attachment devices whose installation is specified in other Sections.
   3. Size and location of initial access modules for acoustical tile.
   4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
   5. Minimum Drawing Scale: 1/8 inch = 1 foot (1:96).

C. Samples for Initial Selection: For components with factory-applied color finishes.

D. Samples for Verification: For each component indicated and for each exposed finish required, prepared on Samples of size indicated below.
   1. Acoustical Tile: Set of full-size Samples of each type, color, pattern, and texture.
   2. Concealed Suspension System Members: 12-inch (300-mm) long Sample of each type.
   3. Exposed Moldings and Trim: Set of 12-inch (300-mm) long Samples of each type and color.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

E. Qualification Data: For testing agency.

F. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each acoustical tile ceiling.

G. Research/Evaluation Reports: For acoustical tile ceiling and components and anchor and fastener type.

H. Maintenance Data: For finishes to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. Acoustical Testing Agency Qualifications: An independent testing laboratory, or an NVLAP-accredited laboratory, with the experience and capability to conduct the testing indicated. NVLAP-accredited laboratories must document accreditation, based on a "Certificate of Accreditation" and a "Scope of Accreditation" listing the test methods specified.

B. Source Limitations:
   1. Acoustical Ceiling Tile: Obtain each type through one source from a single manufacturer.
   2. Suspension System: Obtain each type through one source from a single manufacturer.

C. Fire-Test-Response Characteristics: Provide acoustical tile ceilings that comply with the following requirements:
   1. Fire-Resistance Characteristics: Where indicated, provide acoustical tile ceilings identical to those of assemblies tested for fire resistance per ASTM E 119 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
      a. Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory" or from the listings of another testing and inspecting agency.
      b. Identify materials with appropriate markings of applicable testing and inspecting agency.
   2. Surface-Burning Characteristics: Provide acoustical tiles with the following surface-burning characteristics complying with ASTM E 1264 for Class A materials as determined by testing identical products per ASTM E 84:
      a. Smoke-Developed Index: 450 or less.

D. Seismic Standard: Provide acoustical tile ceilings designed and installed to withstand the effects of earthquake motions according to the following:
   1. Standard for Ceiling Suspension Systems Requiring Seismic Restraint: Comply with ASTM E 580.
   2. CISCA's Recommendations for Acoustical Ceilings: Comply with CISCA's "Recommendations for Direct-Hung Acoustical Tile and Lay-in Panel Ceilings--Seismic Zones 0-2."
   3. CISCA's Guidelines for Systems Requiring Seismic Restraint: Comply with CISCA's "Guidelines for Seismic Restraint of Direct-Hung Suspended Ceiling Assemblies--Seismic Zones 3 & 4."
   4. UBC Standard 25-2, "Metal Suspension Systems for Acoustical Tile and for Lay-in Panel Ceilings."

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

5. ASCE 7, "Minimum Design Loads for Buildings and Other Structures": Section 9, "Earthquake Loads."

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver acoustical tiles, suspension system components, and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.

B. Before installing acoustical tiles, permit them to reach room temperature and a stabilized moisture content.

C. Handle acoustical tiles carefully to avoid chipping edges or damaging units in any way.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not install acoustical tile ceilings until spaces are enclosed and weatherproof, wet work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
   1. Pressurized Plenums: Operate ventilation system for not less than 48 hours before beginning acoustical tile ceiling installation.

1.8 COORDINATION

A. Coordinate layout and installation of acoustical tiles and suspension system with other construction that penetrates ceilings or is supported by them, including but not limited to light fixtures, HVAC equipment, fire-suppression system, speakers, smoke detectors, Unistrut, Owner Furnished Equipment, cubicle curtain and I.V. tracks, and partition assemblies.

1.9 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Deliver to location designated by Owner; obtain signed receipt.
   2. Acoustical Ceiling Units: Full-size tiles equal to 2.0 percent of quantity installed.
   3. Suspension System Components: Quantity of each concealed grid and exposed component equal to 2.0 percent of quantity installed.

PART 2 - PRODUCTS

2.1 ACOUSTICAL TILES, GENERAL

A. Acoustical Tile Standard: Provide manufacturer's standard tiles of configuration indicated that comply with ASTM E 1264 classifications as designated by types, patterns, acoustical ratings, and light reflectances, unless otherwise indicated.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1. Mounting Method for Measuring NRC: Type E-400; plenum mounting in which face of test specimen is 15-3/4 inches (400 mm) away from test surface per ASTM E 795.

B. Acoustical Tile Colors and Patterns: Match appearance characteristics indicated for each product type.

C. Broad Spectrum Antimicrobial Fungicide and Bactericide Treatment: Provide acoustical tiles treated with manufacturer's standard antimicrobial formulation that inhibits fungus, mold, mildew, and gram-positive and gram-negative bacteria and showing no mold, mildew, or bacterial growth when tested according to ASTM D 3273 and evaluated according to ASTM D 3274 or ASTM G 21.

D. Antimicrobial Fungicide Treatment: Provide acoustical tiles with face and back surfaces coated with antimicrobial treatment consisting of manufacturer's standard formulation with fungicide added to inhibit growth of mold and mildew and showing no mold or mildew growth when tested according to ASTM D 3273 and evaluated according to ASTM D 3274 or ASTM G 21.

2.2 ACOUSTICAL TILES FOR ACOUSTICAL TILE CEILING

A. Basis-of-Design Product: Subject to compliance with requirements, provide Armstrong World Industries, Inc. "Endura", a comparable product by one of the following, or approved equal.
1. CertainTeed Corporation.
2. USG Interiors, Inc.
3. Celotex Corporation.

B. Classification: Provide tiles complying with ASTM E 1264 for type, form, and pattern as follows:

C. Type III, mineral base with painted finish; Form 1, water felted.
1. Pattern: F (heavily textured).

D. Color: White.

E. LR: Not less than 0.80.

F. NRC: Not less than 0.70.

G. CAC: Not less than 35.

H. AC: Not less than 180.

I. Edge/Joint Detail: Angled tegular, 15/16-inch.

J. Thickness: 3/4 inch (19 mm).

K. Modular Size: 24 by 24 inches (610 by 610 mm).

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

L. Antimicrobial Treatment: Broad spectrum fungicide and bactericide or fungicide based.

2.3 METAL SUSPENSION SYSTEMS, GENERAL

A. Metal Suspension System Standard: Provide manufacturer's standard metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable requirements in ASTM C 635.

B. Finishes and Colors, General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes. Provide manufacturer's standard factory-applied finish for type of system indicated.

C. Attachment Devices: Size for five times the design load indicated in ASTM C 635, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.
   1. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hangers of type indicated, and with capability to sustain, without failure, a load equal to 10 times that imposed by ceiling construction, as determined by testing per ASTM E 1190, conducted by a qualified testing and inspecting agency.

D. Wire Hangers, Braces, and Ties: Provide wires complying with the following requirements:
   1. Zinc-Coated, Carbon-Steel Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper.
   2. Size: Select wire diameter so its stress at 3 times hanger design load (ASTM C 635, Table 1, "Direct Hung") will be less than yield stress of wire, but provide not less than 0.106-inch (2.69-mm) diameter wire.

E. Hanger Rods: Mild steel, zinc coated or protected with rust-inhibitive paint.

F. Seismic Struts: Manufacturer's standard compression struts designed to accommodate lateral forces.

G. Seismic Clips: Manufacturer's standard seismic clips designed and spaced to secure acoustical tiles in-place.

2.4 METAL SUSPENSION SYSTEM FOR ACOUSTICAL TILE CEILING

A. Basis-of-Design Product: Subject to compliance with requirements, provide Armstrong World Industries, Inc., "15/16-inch Prelude", a comparable product by one of the following, or approved equal.
   1. USG Interiors, Inc.
   2. CertainTeed Corporation.
   3. Celotex Corporation.

B. Direct-Hung, Double-Web, Fire-Rated Suspension System: Main and cross runners roll formed from and capped with cold-rolled steel sheet, prepainted, or hot-dip galvanized according to ASTM A 653/A 653M, G30 (Z90) coating designation.
   1. Structural Classification: Heavy-duty system.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2.5 METAL EDGE MOLDINGS AND TRIM

A. Products: Subject to compliance with requirements, provide product by one of the following; or approved equal.
   1. Armstrong World Industries, Inc.
   2. CertainTeed Corporation.
   3. Chicago Metallic Corporation.
   4. Fry Reglet Corporation.
   5. Gordon, Inc.
   6. USG Interiors, Inc.

B. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that comply with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension system runners.
   1. Provide manufacturer's standard edge moldings that fit acoustical tile edge details and suspension systems indicated and that match width and configuration of exposed runners, unless otherwise indicated.
   2. For circular penetrations of ceiling, provide edge moldings fabricated to diameter required to fit penetration exactly.

C. Extruded-Aluminum Edge Moldings and Trim: Where indicated, provide manufacturer's extruded-aluminum edge moldings and trim of profile indicated or referenced by manufacturer's designations, including splice plates, corner pieces, and attachment and other clips, complying with seismic design requirements and the following:
   1. Aluminum Alloy: Alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than the strength and durability properties of aluminum extrusions complying with ASTM B 221(ASTM B 221M) for Alloy and Temper 6063-T5.
   2. Finish designations prefixed by AA comply with system established by the Aluminum Association for designating aluminum finishes.
   3. Conversion-Coated Finish: AA-M12C42 (Chemical Finish: cleaned with inhibited chemicals; acid-chromate-fluoride-phosphate conversion coating).
   4. Class II, Clear Anodic Finish: AA-M12C22A31 (Mechanical Finish: non-specular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class II, clear coating 0.010 mm or thicker) complying with AAMA 611.
   5. Baked-Enamel Finish: AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: acid-chromate-fluoride-phosphate conversion coating; organic coating: as specified below). Apply baked enamel complying with paint manufacturer's written instructions for cleaning, conversion coating, and painting.
   6. Organic Coating: Thermosetting, enamel primer/topcoat system with a minimum dry film thickness of 0.8 to 1.2 mils (0.02 to 0.03 mm).

2.6 ACOUSTICAL SEALANT

A. Products: Subject to compliance with requirements, provide one of the following; or approved equal.
   1. Acoustical Sealant for Exposed and Concealed Joints:
   2. Pecora Corporation; AC-20 FTR Acoustical and Insulation Sealant.
   3. USG Corporation; SHEETROCK Acoustical Sealant.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Acoustical Sealant for Exposed and Concealed Joints: Manufacturer's standard nonsag, paintable, nonstaining latex sealant**,** with a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24), complying with ASTM C 834 and effective in reducing airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, including structural framing and substrates to which acoustical tile ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of acoustical tile ceilings.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Measure each ceiling area and establish layout of acoustical tiles to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width tiles at borders, and comply with layout shown on reflected ceiling plans.

3.3 INSTALLATION, SUSPENDED ACOUSTICAL TILE CEILINGS

A. General: Install acoustical tile ceilings to comply with ASTM C 636 and seismic design requirements indicated, per manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."

B. Suspend ceiling hangers from building's structural members and as follows:
   1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
   2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
   3. Secure wire hangers to ceiling suspension members and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
   4. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, postinstalled mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
   5. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
   6. Do not attach hangers to steel deck tabs.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

7. Do not attach hangers to steel roof deck. Attach hangers to structural members.
8. Space hangers not more than 48 inches (1200 mm) o.c. along each member supported directly from hangers, unless otherwise indicated; provide hangers not more than 8 inches (200 mm) from ends of each member.
9. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.

C. Install edge moldings and trim of type indicated at perimeter of acoustical tile ceiling area and where necessary to conceal edges of acoustical tiles.
1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
2. Screw attach moldings to substrate at intervals not more than 16 inches (400 mm) o.c. and not more than 3 inches (75 mm) from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet (3.2 mm in 3.6 m). Miter corners accurately and connect securely.
3. Do not use exposed fasteners, including pop rivets, on moldings and trim.

D. Install suspension system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.

E. Arrange directionally patterned acoustical tiles as follows:
1. As indicated on Floor Plan.

F. Install acoustical tiles in coordination with suspension system and exposed moldings and trim. Place splines or suspension system flanges into kerfed edges so tile-to-tile joints are closed by double lap of material.
1. Fit adjoining tile to form flush, tight joints. Scribe and cut tile for accurate fit at borders and around penetrations through tile.
2. Hold tile field in compression by inserting leaf-type, spring-steel spacers between tile and moldings, spaced 12 inches (305 mm) o.c.
3. Paint all exposed cut edges with manufacturers touch-up paint.
4. Cut all tegular tile edges to match tegular edge along exposed edges and paint with manufacturers touch-up paint.
5. Protect lighting fixtures and air ducts to comply with requirements indicated for fire-resistance-rated assembly.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections and prepare test reports.

B. Tests and Inspections: Testing and inspecting of completed installations of acoustical tile ceiling hangers and anchors and fasteners shall take place in successive stages, in areas of extent and using methods as follows. Do not proceed with installations of acoustical tile ceiling hangers for the next area until test results for previously completed installations of acoustical tile ceiling hangers show compliance with requirements.
1. Extent of Each Test Area: When installation of ceiling suspension systems on each floor has reached 20 percent completion but no tiles have been installed.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

a. Within each test area, testing agency will select 1 of every 10 power-actuated fasteners and postinstalled anchors used to attach hangers to concrete and will test them for 200 lbf (890 N) of tension; it will also select one of every 2 postinstalled anchors used to attach bracing wires to concrete and will test them for 440 lbf (1957 N) of tension.
b. When testing discovers fasteners and anchors that do not comply with requirements, testing agency will test those anchors not previously tested until 20 pass consecutively and then will resume initial testing frequency.

C. Remove and replace acoustical tile ceiling hangers and anchors and fasteners that do not pass tests and inspections and retest as specified above.

3.5 CLEANING

A. Clean exposed surfaces of acoustical tile ceilings, including trim and edge moldings. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage. Remove and replace tiles and other ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes surface preparation and application of elastomeric coatings to the following exterior substrates:
   1. Concrete.
   2. Concrete unit masonry.

1.3 PERFORMANCE REQUIREMENTS

A. Provide elastomeric coating systems with the following properties as determined by test methods indicated:
   1. Elongation: Not less than 100 percent with a tensile strength of 200 psi (1379 kPa) and not less than 88 percent recovery after 1 hour and 90 percent recovery after 24 hours when tested according to ASTM D 2370 using parameters established by MPI 113.
   2. Accelerated Weathering: No cracking, peeling, blistering, chalking, or visual deterioration after 1000 hours when tested according to procedures in ASTM G 155.
   3. Low-Temperature Flexibility: No crack formation when tested according to ASTM D 1737.
   4. Moisture-Vapor Transmission: Not less than 2.0 perms (115 ng/Pa x s x sq. m) according to ASTM D 1653.
   5. Wind-Driven Rain Resistance: No water penetration according to procedures in FS TT-C-555.
   6. Minimum Solids Content by Volume: Not less than 45 percent.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples for Initial Selection: For each type of elastomeric coating indicated.

C. Samples for Verification: For each type of elastomeric coating indicated and in each color and gloss.
   1. Submit Samples on same type of substrate as that to receive application, 8 inches (200-mm) square.
   2. Step coats on Samples to show each separate coat, including primers and block fillers as applicable.
   3. Label each coat of each Sample.
   4. Label each Sample for location and application area.

D. Product List: For each product indicated, including the following:

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1. Cross-reference to coating system and locations of application areas. Use same designations indicated on Drawings and in schedules.
2. Manufacturer's recommended spreading rate for each separate coat, including primers and block fillers for each type of substrate as applicable.

1.5 QUALITY ASSURANCE

A. Applicator Qualifications: A firm or individual experienced in applying elastomeric coating systems similar in material and extent to those indicated for this Project, whose work has resulted in applications with a record of successful in-service performance.

B. Source Limitations: Obtain crack fillers, block fillers, primers, and other undercoat materials from same manufacturer as finish coats.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F (deg C).
1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.

1.7 PROJECT CONDITIONS

A. Apply coatings only when temperature of surfaces to be coated and ambient air temperatures are between 50 and 90 deg F (10 and 32 deg C) unless otherwise permitted by manufacturer's written instructions.

B. Do not apply coatings in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.

C. Allow wet surfaces to dry thoroughly and attain temperature and conditions specified before starting or continuing coating operation.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace elastomeric coatings that fail within specified warranty period.
1. Failures include, but are not limited to, the following:
   a. Water penetration through the coating.
   b. Deterioration of coating beyond normal weathering.
2. Warranty Period: Five years from date of Substantial Completion.

1.9 EXTRA MATERIALS

A. Furnish extra materials that are from same production run (batch mix) as materials applied and that are packaged for storage in unopened, factory-sealed containers for storage and identified with labels describing contents.
1. Quantity: Furnish an additional 5 percent but not less than 1 gal. (3.8 L) of each material, color, and texture applied.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Material Compatibility:
1. Provide elastomeric finish coatings and crack fillers, primers, and block fillers as applicable for use within elastomeric finish coatings that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. For each material or coat, provide products and spreading rates recommended in writing by elastomeric coating manufacturer for use on substrate indicated.

2.2 ELASTOMERIC FINISH COATINGS

A. Exterior Flat Waterborne, Pigmented Elastomeric Coating.
1. Products: Subject to compliance with requirements, provide one of the following; or approved equal.
   a. PPG Industries; Pitt-Flex Elastomeric Coating.
   b. Sherwin-Williams Company (The); Sherlastic Elastomeric Coating.
   c. BASF Building Systems; Sonneborn Colorflex.
   d. Sto Corp.; Stolastic.
   e. Tnemec Company, Inc.; Enviro-Crete Series.
2. Surface Profile: Smooth texture.
3. VOC Content: 100 g/L or less.

2.3 OTHER MATERIALS

A. Crack Fillers: Elastomeric coating manufacturer's recommended, factory-formulated crack fillers or sealants, including crack filler primers, compatible with substrate and other materials indicated; VOC content complying with limits of authorities having jurisdiction.

B. Primer: Elastomeric coating manufacturer's recommended, factory-formulated, alkali-resistant primer compatible with substrate and other materials indicated.
1. VOC Content: 100 g/L or less.
2. Concrete and Masonry Primer: Factory-formulated, alkali-resistant, acrylic-latex primer.
   a. Pittsburgh Paints; Speedhide Alkali Resistant Primer 6-603: Applied at a dry film thickness of not less than 1.5 mils (0.038 mm).
   b. Sherwin Williams; Loxon Conditioner #A24W100: Applied at a dry film thickness of not less than 1.5 mils.
   c. BASF Building Systems; Sonneborn Colorflex Sealer #751: Applied at a dry film thickness of not less than 1.3 mils (0.033 mm).
   d. Sto; Flexible Coating CR212 Thinned 1:5 with 1 Gal. (3.8 L) of Water per Each 5 Gal. (19 L) of CR212: Applied at a dry film thickness of not less than 10 mils (0.254 mm).
   e. Or approved equal.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

C. Concrete Unit Masonry Block Filler: Elastomeric coating manufacturer's recommended, factory-formulated, high-performance latex block filler compatible with substrate and other materials indicated.
   1. Pittsburgh Paints; 16-90 High-Performance Acrylic Block Filler: Applied at a dry film thickness of not less than 6.0 mils (0.152 mm).
   2. Sherwin Williams; Heavy Duty Block Filler #B42W46: Applied at a dry film thickness of not less than 10 mils.
   3. BASF Building Systems; Sonneborn; Colorflex Block Filler #749: Applied at a dry film thickness of not less than 1.3 mils (0.033 mm).
   4. Sto; Flexible Coating CR212 Thinned 1:5 with 1 Gal. (3.8 L) of Water per Each 5 Gal. (19 L) of CR212: Applied at a dry film thickness of not less than 10 mils (0.254 mm).
   5. Or approved equal.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with manufacturer's requirements for maximum moisture content, alkalinity, and other conditions affecting performance of work.

B. Begin coating only when moisture content of substrate is 12 percent or less when measured with an electronic moisture meter.

C. Begin coating no sooner than 28 days after substrate is constructed and is visually dry on both sides.

D. Verify that substrate is within the range of alkalinity recommended by manufacturer.

E. Verify suitability of substrates including surface conditions and compatibility Proceed with existing finishes and primers.

F. Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry.

3.2 PREPARATION

A. Comply with manufacturer's written instructions applicable to substrates and coating systems indicated.

B. Remove hardware and hardware accessories, plates, machined surfaces, light fixtures, and similar items already installed that are not to be coated. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and coating.
   1. After completing coating operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

C. Clean substrates of substances that could impair bond of coatings, including dirt, oil, grease, and incompatible paints and encapsulants. Do not coat surfaces if moisture content or alkalinity of surfaces to be coated exceeds that permitted in manufacturer's written instructions.
   1. Remove incompatible primers and reprime substrate with compatible primers as required to produce coating systems indicated.
   2. Perform cleaning and coating application so dust and other contaminants from cleaning process will not fall on wet, newly coated surfaces.

D. Crack Repair: Fill cracks according to manufacturer's written instructions before coating surfaces.

3.3 APPLICATION

A. Apply elastomeric coatings according to manufacturer's written instructions.
   1. Use equipment and techniques best suited for substrate and type of material being applied.
   2. Coat surfaces behind movable items the same as similar exposed surfaces.
   3. Apply each coat separately according to manufacturer's written instructions.

B. Primers: Apply at a rate to ensure complete coverage.

C. Block Fillers: Apply at a rate to ensure complete coverage with pores filled.

D. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats similar to color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.

E. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform finish, color, and appearance.

F. Apply coatings to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

G. Apply coatings to prepared surfaces as soon as practicable after preparation and before subsequent surface soiling or deterioration.

H. Spray Application: Use spray equipment for application only when permitted by authorities having jurisdiction. Wherever spray application is used, do not double back with spray equipment to build up film thickness of two coats in one pass.

3.4 FIELD QUALITY CONTROL

A. Testing of Paint Materials: Owner reserves the right to invoke the following testing procedures:
   1. Owner will engage the services of a qualified testing agency to sample materials being used. Samples of material delivered to Project site will be taken, identified, sealed, and certified in presence of Contractor.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2. Testing agency will perform tests for compliance of materials with product requirements.
3. Owner may direct Contractor to stop coating application if test results show materials being used do not comply with requirements. Remove noncomplying materials from Project site, pay for testing, and recoat surfaces that were coated with rejected materials. Remove rejected materials from previously coated surfaces if, on recoating with complying materials, the two coatings are incompatible.

B. Field Testing and Inspection: Owner reserves the right to engage the services of a qualified testing agency to verify installed thickness of elastomeric coatings.

3.5 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. After completing coating application, clean spattered surfaces. Remove spattered coatings by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from coating application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

D. At completion of construction activities, touch up and restore damaged or defaced coated surfaces.

3.6 COATING SCHEDULE

A. Concrete Substrates:
1. Primer: Concrete primer if required by manufacturer.
2. Elastomeric Finish Coat(s): Minimum two coats with a total dry film thickness of 16 to 18 mils (0.41 to 0.45 mm).
3. Finish-Coat Color: As selected by Architect from manufacturer's full range.

B. Concrete Unit Masonry Substrates:
1. Primer: Concrete unit masonry primer if required by manufacturer.
2. Block Filler: Concrete unit masonry block filler if required by manufacturer.
3. Elastomeric Finish Coat(s): Minimum two coats with a total dry film thickness of 16 to 18 mils (0.41 to 0.45 mm).
4. Finish-Coat Color: As selected by Architect from manufacturer's full range.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This section includes requirements for surface preparation, shop priming, field priming, and/or field painting of all exposed items and surfaces throughout the project, unless otherwise indicated, as specified herein and shown on the Drawings.

B. All exposed items and surfaces shall be painted using the appropriate coating system as specified herein. Coating system schedules and finish schedules may be provided herein and/or on the Drawings, which identify specific paint systems and paint colors to be used on specific items and surfaces. However, these schedules do not necessarily cover all items to be painted. Where the selection of a specific painting system for a particular application is not clear, it shall be the responsibility of the Contractor to request clarification from the Engineer.

C. Surface preparation, priming, and coats of paint specified are in addition to shop priming and surface pretreatment specified in other sections, unless otherwise indicated.

D. All exposed surfaces shall be painted except where the natural finish of the material is scheduled to be the finished surface or if the surface is specifically noted not to be painted.

E. See "Protective Coatings - Supplement" located at the end of this Section but in general, items to be painted include:
   1. All exposed exterior surfaces including:
      a. All ferrous metal structures, equipment; machinery and supports, except those items fabricated from stainless steel;
      b. All exterior, above-ground ductile iron; galvanized and non-galvanized steel; and PVC piping, fittings, hydrants, valves, and floor stands, including piping, fittings and valves in vaults and manholes;
      c. All cast-in-place structural concrete exposed to view including above-grade foundation walls to an elevation 12-inches below finished grade, roofs not shown on the Drawings to receive any other treatment, above-grade basin exterior walls to an elevation 12-inches below finished grade, piping and equipment supports;
      d. All factory-primed surfaces; and
      e. All other surfaces subject to corrosion.
   2. All exposed interior surfaces including:
      a. All ferrous metal structures, equipment; machinery and supports, except those items fabricated from stainless steel;
      b. All ductile iron and PVC piping, hydrants and valves;
      c. All ferrous and non-ferrous miscellaneous metals except those items fabricated from stainless steel;

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

d. Coating all cast-in-place structural concrete exposed to view including columns, equipment pads, wastewater holding structure walls and floors, and pipe supports;
e. Ductwork and appurtenances;
f. Metal;
g. All electrical conduit exposed to view, unless specifically noted not to be painted;
h. All hangers and supports for overhead items;
i. All factory primed surfaces;
j. Painting all factory-primed surfaces; and
k. All other surfaces subject to corrosion.

3. Equipment that does not have an approved final coat or approved finished color.
4. Touch up all existing or new equipment, items, and surfaces damaged by construction as requested by the Engineer.

F. In general, items NOT to be painted include:
1. Items with Engineer approved factory finish.
2. Electrical equipment unless specifically noted.
3. Surfaces hidden from view including piping, conduit, ducts, and insulation. Note, the manufacturer's standard coatings, if any, may remain.
4. Stainless steel surfaces, except piping or tubing.
5. Aluminum surfaces except:
a. Where specifically noted to be painted.
b. Where embedded in or in contact with concrete.
c. Where in contact with dissimilar metals.
d. Piping or tubing.
6. Fiberglass surfaces, except piping and piping appurtenances.
7. Interior of pipe, ductwork, and conduits, unless noted otherwise.
8. Moving parts of mechanical and electrical units where painting would interfere with the operation of the unit.
9. Code labels and equipment identification and rating plates.
10. Non-metal ducts and appurtenances.
11. Pre-finished metal.

1.3 REFERENCES

A. The following is a list of standards which may be referenced in this Section:
1. American Water Works Association (AWWA).
2. Environmental Protection Agency (EPA).
3. Occupational Safety and Health Act (OSHA).
4. The Society for Protective Coatings (SSPC):
a. PA 2, Measurement of Dry Coating Thickness with Magnetic Gages.
b. PA 3, Guide to Safety in Paint Applications.
c. SP 1, Solvent Cleaning.
d. SP 2, Hand Tool Cleaning.
e. SP 3, Power Tool Cleaning.
f. SP 5, White Metal Blast Cleaning.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

g. SP 6, Commercial Blast Cleaning.
h. SP 7, Joint Surface Preparation Standard Brush-Off Blast Cleaning.
i. SP 10, Near-White Blast Cleaning.
j. SP 11, Power Tool Cleaning to Bare Metal.
k. SP 12, Surface Preparation and Cleaning of Metals Waterjetting Prior to Recoating.
l. SP 13, Surface Preparation of Concrete.

1.4 DEFINITIONS

A. Definitions of Painting Terms: ASTM D16, unless otherwise specified.

B. Dry Film Thickness (DFT): Thickness of a coat of paint in fully cured state measured in mils (1/1000 inch).

C. Areas considered to be "Severe Atmospheres" are those that may at any time hold raw wastewater or gases from raw wastewater.

1.5 SUBMITTALS

A. The Contractor shall submit shop drawings and product data to the Engineer in accordance with the requirements of Division 01 Section “Submittal Procedures”.

B. Action Submittals:
1. Shop Drawings:
   a. Data Sheets:
      1) For each product, furnish a Product Data Sheet (PDS), the manufacturer's technical data sheets, and color selection charts of the paint colors available (where applicable).
      2) Technical and performance information that demonstrates compliance with Specifications.

C. Informational Submittals:
1. Applicator's Qualification: List of references substantiating experience.
2. Factory Applied Coatings: Manufacturer's certification stating factory applied coating system meets or exceeds requirements specified.
3. Manufacturer's written verification that submitted material is suitable for the intended use.
4. If the manufacturer of finish coating differs from that of shop primer, provide finish coating manufacturer's written confirmation that materials are compatible.
5. Manufacturer's written instructions and special details for applying each type of paint.

D. Color Samples: Submit Manufacturer’s color samples showing full range of standard colors.

E. Manufacturer’s Quality Assurance: Submit Manufacturer’s certification that coatings comply with specified requirements and are suitable for intended application.

F. Applicator’s Quality Assurance:

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1. Submit list of a minimum of 3 completed projects of similar size and complexity to this work. Include for each project:
   a. Project name and location.
   b. Name of Owner.
   c. Name of Contractor.
   d. Name of Engineer.
   e. Name of coating manufacturer.
   f. Approximate area of coatings applied.
   g. Date of completion.
   h. Type of primer and coating applied.

G. Warranty: Submit a complete description of the warranty to be provided for approval.

H. Painting Schedule: Contractor shall submit a schedule of all items (structures, equipment, pipe, etc.) to be painted prior to beginning painting operations. Schedule shall include, but not be limited to, items to be painted, surface preparation, paint system, and color. The schedule shall be submitted to the Engineer for approval at which time the Engineer and Owner will select the colors to be used that are not specified herein or on the Drawings.

1.6 QUALITY ASSURANCE

A. Manufacturer's Qualifications:
   1. Specialize in manufacture of coatings and have personnel that have been regularly engaged in the design and manufacture of protective coatings.
   2. Able to demonstrate successful performance on comparable projects.
   3. Single Source Responsibility: Coatings and coating application accessories shall be products of a single manufacturer.
   4. Provide a list of references (name, location, and contact information) of at least three applications currently using the same or similar coatings proposed located in the United States.

B. Applicator's Qualifications:
   1. Experienced in application of specified coatings and have personnel that have been regularly engaged in the application of protective coatings for projects of similar size and complexity to this work.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Delivery:
   1. Deliver materials to site in accordance with the Coatings Coordination Schedule in manufacturer's original, unopened containers and packaging, with labels clearly identifying:
      a. Coating or material name.
      b. Manufacturer.
      c. Color name and number.
      d. Batch or lot number.
      e. Date of manufacture.
      f. Mixing and thinning instructions.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2. Where precoated items are to be shipped to the job site, protect coating from damage. Batten coated items to prevent abrasion.
3. Protect shop painted surfaces during shipment and handling by suitable provisions including padding, blocking, and use of canvas or nylon slings.

B. Storage:
1. Store materials in a clean dry area and within temperature range in accordance with Manufacturer's instructions.
2. Keep containers sealed until ready for use.
3. Do not use materials beyond Manufacturer's shelf life limits.
4. Primed surfaces shall not be exposed to weather for more than two months before being topcoated, or less time if recommended by coating manufacturer.

C. Handling: Protect materials during handling and application to prevent damage or contamination.

1.8 ENVIRONMENTAL REQUIREMENTS

A. Weather:
1. Prepare surfaces and apply and cure coatings within air and surface temperature range in accordance with Manufacturer's instructions.
2. Surface temperature shall be a minimum of 5 degrees F (3 degrees C) above dew point.
3. Prepare surfaces and apply coatings within relative humidity range in accordance with Manufacturer's instructions.
4. Do not prepare surfaces or apply coatings in rain, snow, fog, or mist.
5. Do not spray coatings if wind velocity is above manufacturer's limit.

B. Ventilation: Provide ventilation during coating evaporation stage in confined or enclosed areas in accordance with OSHA standards.

C. Dust and Contaminants
1. Schedule coating work to avoid excessive dust and airborne contaminants.
2. Protect work areas from dust and airborne contaminants during coating application and curing.

1.9 TESTING EQUIPMENT

A. The Contractor shall furnish and make available to the Engineer one week prior to surface preparation the following items of testing equipment for use in determining if requirements of this section are being satisfied. Specified items of equipment shall be available for the Engineer's use at all times when field painting or surface preparation is in progress.

B. Wet film gauge.

C. Surface thermometer.

D. Keane-Tator surface profile comparator.

E. Set of National Association of Corrosion Engineers (NACE) visual standards.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

F. Holiday (pin hole) detector (low voltage).

G. Sling-psychrometer.

H. Magnetic dry film gauge.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Approved manufacturers include:
   1. Tnemec Company, Inc.
   2. Approved equal.

B. Specified products are those manufactured by TNEMEC Company, Inc. and are specified as the standard of quality required for use on this project. Equivalent products by other manufacturers are acceptable, providing they meet or exceed all performance criteria of the specified materials.

2.2 ABRASIVE MATERIALS

A. Select abrasive type and size to produce surface profile that meets coating manufacturer's recommendations for specific primer and coating system to be applied.

2.3 PAINT MATERIALS

A. General:
   1. Manufacturer's highest quality products suitable for intended service.
   2. Compatibility: Only compatible materials from a single manufacturer shall be used in the work. Particular attention shall be directed to compatibility of shop-applied primers and field-applied finish coats. Shop applied primer manufacturer information shall be required in the submittal for each product and made available to final coating manufacturer.
   3. Thinners, Cleaners, Driers, and Other Additives: As recommended by coating manufacturer.

2.4 MIXING

A. Multiple-Component Coatings:
   1. Prepare using each component as packaged by paint manufacturer.
   2. No partial batches will be permitted.
   3. Do not use multiple-component coatings that have been mixed beyond their pot life.
   4. Furnish small quantity kits for touch-up painting and for painting other small areas.
   5. Mix only components specified and furnished by paint manufacturer.
   6. Do not intermix additional components for reasons of color or otherwise, even within the same generic type of coating.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Colors: Formulate paints with colorants free of lead, lead compounds, or other materials that might be affected by presence of hydrogen sulfide or other gas likely to be present at the site.

2.5 SHOP FINISHES

A. Shop Blast Cleaning and Coating Requirements:
   1. Equipment:
      a. When required by equipment specifications, such equipment shall be primed and finish coated in shop by manufacturer and touched up in field with identical material after installation.
      b. Where manufacturer's standard coating is not suitable for intended service condition, Engineer may approve use of a tie-coat to be used between manufacturer's standard coating and specified field finish. In such cases, tie-coat shall be surface tolerant epoxy as recommended by manufacturer of specified field finish coat. Coordinate details of equipment manufacturer's standard coating with field coating manufacturer.

2.6 COATING SYSTEMS FOR STEEL – STRUCTURAL, TANKS, PIPE, AND EQUIPMENT

A. Exterior Exposed Steel (Non-Immersed):
   1. System Type: Polyamidoamine Epoxy/Polyurethane.
   2. Surface Preparation: SSPC-SP 6.
   3. Primer: Series N(L)69-1255 Hi-Build Epoxoline II. DFT 4.0 to 6.0 mils.
   4. Finish Coat: Series 1074/1075 Color Endura-Shield. DFT 2.0 to 3.0 mils.
   5. Total DFT: 6.0 to 9.0 mils.
   6. Finish Color: As selected by Engineer from Manufacturer’s standard colors.

B. Interior Exposed Steel (Non-Immersed):
   1. System Type: Epoxy.
   2. Surface Preparation: SSPC-SP 6.
   3. Primer: Series N(L)69-1255 Hi-Build Epoxoline II. DFT 4.0 to 6.0 mils.
   4. Finish Coat: Series N69 Color Hi-Build Epoxoline II. DFT 4.0 to 6.0 mils.
   5. Total DFT: 8.0 to 12.0 mils.
   6. Finish Color: As selected by Engineer from Manufacturer’s standard colors.

C. Immersed Steel (Non-Potable Water):
   1. System Type: Epoxy.
   2. Surface Preparation: SSPC-SP 10.
   3. Primer: Series N(L)69-1255 Hi-Build Epoxoline II. DFT 4.0 to 6.0 mils.
   4. Finish Coat: Series N69 Color Hi-Build Epoxoline II. DFT 4.0 to 6.0 mils.
   5. Total DFT: 8.0 to 12.0 mils.
   6. Finish Color: As selected by Engineer from manufacturer’s standard colors.

D. Interior Exposed Steel/Immersed Steel/Intermittent Immersion (For Severe Atmospheres):
   1. System Type: Polyurethane.
   2. Surface Preparation: SSPC-SP 5 with minimum 3.0-mil profile.
   3. Primer: Series 446 Perma-Shield. DFT 5.0 to 10.0 mils.
   4. Finish Coat: Series 446 Perma-Shield. DFT 5.0 to 10.0 mils.
   5. Total DFT: 10.0 to 20.0 mils.
   6. Finish Color: As selected by Engineer from manufacturer’s standard colors.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

E. Below Grade Steel:
1. System Type: Coal tar epoxy.
2. Surface Preparation: SSPC-SP 10.
3. Primer: Series N(L)69-1255 Hi-Build Epoxoline II. DFT 3.0 to 5.0 mils.
4. Finish Coat: Series 46H-413 Hi-Build Tneme-Tar. DFT 16.0 to 20.0 mils.
5. Total DFT: 19.0 to 25.0 mils.
6. Finish Color: Black.

F. Interior/Exterior Exposed Steel (For High Temperature Service):
1. System Type: High heat silicone.
2. Surface Preparation: SSPC-SP10.
3. Primer: Thurmalox 210 Primer (Dampney Company). DFT 2.0 to 2.5 mils.
4. Finish Coat: Thurmalox 200 Series (Dampney Company). DFT 2.0 to 2.5 mils.
5. Total DFT: 4.0 to 5.0 mils.
6. Finish Color: As specified in color schedule.

2.7 COATING SYSTEMS FOR GALVANIZED STEEL AND NONFERROUS METAL – PIPE AND MISCELLANEOUS FABRICATIONS

A. Exterior Exposed Galvanized Steel and Nonferrous Metal (Non-Immersed):
1. System Type: Epoxy/Polyurethane.
2. Surface Preparation: In accordance with Manufacturer's instructions.
3. Primer: Series N(L)69-1255 Hi-Build Epoxoline II. DFT 4.0 to 6.0 mils.
4. Finish Coat: Series 1074/1075 color Endura-Shield. DFT 2.0 to 3.0 mils.
5. Total DFT: 6.0 to 9.0 mils.
6. Finish Color: Piping shall be as specified in color schedule. Miscellaneous fabrications as selected by Engineer from Manufacturer's standard colors.

B. Interior Exposed Galvanized Steel and Nonferrous Metal (Non-Immersed):
1. System Type: Epoxy.
2. Surface Preparation: In accordance with Manufacturer's instructions.
3. Primer: Series N(L)69-1255 color Hi-Build Epoxoline II. DFT 4.0 to 6.0 mils.
4. Finish Coat: Series N69 color Hi-Build Epoxoline II. DFT 4.0 to 6.0 mils.
5. Total DFT: 8.0 to 12.0 mils.
6. Finish Color: Piping shall be as specified in color schedule. Miscellaneous fabrications as selected by Engineer from Manufacturer's standard colors.

C. Immersed Galvanized Steel and Nonferrous Metal (Non-Potable Water):
1. System Type: Epoxy.
2. Surface Preparation: SSPC-SP 1 followed by abrasive blast.
3. Primer: Series N(L)69-1255 Hi-Build Epoxoline II. DFT 4.0 to 6.0 mils.
4. Finish Coat: Series N69 color Hi-Build Epoxoline II. DFT 4.0 to 6.0 mils.
5. Total DFT: 8.0 to 12.0 mils.
6. Finish Color: Piping shall be as specified in color schedule. Miscellaneous fabrications as selected by Engineer from Manufacturer's standard colors.

2.8 COATING SYSTEMS FOR DUCTILE OR CAST IRON – PIPE, PUMPS AND VALVES

A. Exterior Exposed Ductile or Cast Iron (Non-Immersed):

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1. System Type: Epoxy/Polyurethane.
2. Surface Preparation: In accordance with Manufacturer's instructions. Remove black coating in accordance with NAPF 500.03.
3. Primer: Series N(L) 69 color Hi-Build Epoxoline II. DFT 4.0 to 6.0 mils.
4. Finish Coat: Series 1074/1075 color Endura-Shield. DFT 3.0 to 5.0 mils.
5. Total DFT: 7.0 to 11.0 mils.
6. Finish Color: As specified in color schedule.

B. Interior Exposed Ductile or Cast Iron (Non Immersed):
1. System Type: Epoxy.
2. Surface Preparation: In accordance with Manufacturer's instructions. Remove black coating in accordance with NAPF 500 03.
3. Primer: Series N(L) 69 color Hi-Build Epoxoline II. DFT 4.0 to 6.0 mils.
4. Finish Coat: Series N(L) 69 color Hi-Build Epoxoline II. DFT 4.0 to 6.0 mils.
5. Total DFT: 8.0 to 12.0 mils.
6. Finish Color: As specified in color schedule.

C. Interior Exposed and/or Immersed Ductile or Cast Iron (For Severe Atmospheres):
1. System Type: Polyurethane.
2. Surface Preparation: Blast in accordance with NAPF-500.3 and manufacturer's instructions.
3. Primer: Series 1 Omnithane. DFT 2.5 to 3.5 mils.
4. Intermediate Coat: Series 446 Perma-Shield MCU. DFT 5.0 to 10.0 mils.
5. Finish Coat: Series 446 Perma-Shield MCU. DFT 5.0 to 10.0 mils.
6. Total DFT: 12.5 to 23.5 mils.
7. Finish Color: 1222 Gray.

D. Interior/Exterior Exposed Ductile or Cast Iron (For High Temperature Service):
1. System Type: High heat silicone.
2. Surface Preparation: NAPF-500.3.
3. Primer: Thurmalox 210 Primer (Dampney Company). DFT 2.0 to 2.5 mils.
4. Finish Coat: Thurmalox 200 Series (Dampney Company). DFT 2.0 to 2.5 mils.
5. Total DFT: 4.0 to 5.0 mils.
6. Finish Color: As specified in color schedule.

E. Below Ground Ductile or Cast Iron (For below ground pipe that has not been factory coated):
1. System Type: Coal tar epoxy.
2. Surface Preparation: Blast in accordance with NAPF-500.3 and Manufacturer's instructions.
3. Primer: Series N69 Hi-Build Epoxoline. DFT 3.0 to 5.0 mils.
4. Finish Coat: Series 46H-413 Hi-Build Tneme-Tar. DFT 14.0 to 20.0 mils.
5. Total DFT: 17.0 to 25.0 mils.
6. Finish Color: Black.

2.9 COATING SYSTEMS FOR INSULATED PIPE

A. Interior/Exterior Exposed Insulated Pipe:
1. System Type: Acrylic.
2. Surface Preparation: Clean and dry.
3. Primer: Series 6 Color Tneme-Cryl. DFT 2.0 to 3.0 mils.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

4. Finish Coat: 1028/1029 Color Tneme-Cryl. DFT 2.0 to 3.0 mils.
5. Total DFT: 4.0 to 6.0 mils.
6. Finish Color: As specified in color schedule.

2.10 COATING SYSTEMS FOR PRECAST CONCRETE, AND CAST-IN-PLACE CONCRETE

A. Exterior Exposed Concrete:
1. System Type: Acrylic.
2. Surface Preparation: SSPC-SP 13/NACE 6. ICRI, CSP-1 to CSP-3.
3. Primer: None.
4. Finish Coat: Series 180/181 Color W.B. Tneme-Crete. DFT 6.0 to 8.0 mils.
5. Total DFT: 6.0 to 8.0 mils.
6. Finish Color: As selected by Engineer from Manufacturer's standard colors.

B. Below Grade Concrete:
1. System Type: Coal tar epoxy.
2. Surface Preparation: SSPC-SP 13/NACE 6. ICRI, CSP-3 to CSP-5.
3. Primer: None.
4. Finish Coat: 46H-413 Hi-Build Tneme-Tar. DFT 12.0 to 16.0 mils.
5. Total DFT: 12.0 to 16.0 mils.
6. Finish Color: Gray.

C. Exterior Immersed Concrete:
1. System Type: Epoxy.
2. Surface Preparation: SSPC-SP 13/NACE 6. ICRI, CSP-3 to CSP-5.
3. Filler Coat: Fill flush all bug holes and voids with Series 215 Surfacer.
4. Primer: Series 446 Perma-Shield MC. DFT 6.0 to 10.0 mils.
5. Finish Coat: Series 446 Perma-Shield MC. DFT 6.0 to 10.0 mils.
6. Total DFT: 12.0 to 20.0 mils.
7. Finish Color: Gray.

D. Interior Exposed Concrete and CMU (Non-Immersed):
1. System Type: Epoxy.
2. Surface Preparation: SSPC-SP 13/NACE 6. ICRI, CSP-3 to CSP-5.
3. Primer: None.
4. Intermediate Coat: 84 Color Ceramlon ENV. at 70 to 80 sq.ft./gal.
5. Finish Coat: Series 84 Color Ceramlon ENV. DFT 6.0 to 8.0 mils.
6. Total DFT: 12.0 to 24.0 mils.
7. Finish Color: As selected by Engineer from Manufacturer's standard colors.

E. Interior Exposed Concrete/Immersed Concrete (Severe Atmospheres):
1. System Type: Fiber-Reinforced Modified Polyamine Epoxy.
2. Surface Preparation: SSPC-SP 13/NACE 6. Shot blast.
3. Primer: Series 201 Epoxoprime. DFT Horizontal 6 to 12 mils; Vertical 4 to 6 mils.
4. Finish Coat: Series 435 Perma-Glaze, DFT 15.0 to 20.0 mils.
5. Total DFT: 71 to 157 mils.
6. Finish Color: 5001 Gray.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2.11 COATING SYSTEMS FOR CONCRETE FLOORS

A. Light Traffic/Low Impact Exposure Concrete Floors:
   1. System Type: Epoxy/Polyurethane.
   2. Surface Preparation: SSPC-SP 13/NACE 6. Shot blast or mechanically abrade.
   3. Primer: Series 66 Hi-Build Epoxoline. DFT 2.0 to 3.0 mils.
   4. Intermediate Coat: Series 66 Hi-Build Epoxoline. DFT 2.0 to 3.0 mils.
   5. Finish Coat: Series 291 CRU. DFT 1.5 to 2.5 mils.
   6. Total DFT: 5.5 to 8.5 mils.
   7. Finish Color: As selected by Engineer from Manufacturer's standard colors.

B. Severe Chemical, Abrasion, and Traffic Exposure Concrete Floors:
   1. System Type: High-solids epoxy.
   2. Surface Preparation: SSPC-SP 13/NACE 6. Shot blast or mechanically abrade.
   3. Primer: Series 201 Epoxoprime. DFT 6.0 to 8.0 mils.
   4. Intermediate Coat: Series 275 Color Stranlok. DFT 25.0 to 40.0 mils.
   5. Finish Coat: Series 282 Color Tneme-Glaze. DFT 6.0 to 8.0 mils.
   6. Total DFT: 37.0 to 56.0 mils.
   7. Finish Color: As selected by Engineer from Manufacturer's standard colors.

2.12 COATING SYSTEMS - FOR FIBERGLASS PIPE

A. Above-Grade Pipe:
   1. System Type: Polyamide Epoxy / Aliphatic Acrylic Polyurethane.
   2. Surface Preparation: SSPC-SP10/NACE 2 Near-White Blast Cleaning.
   3. Primer: Series 66, DFT 4.0 to 6.0 mils (two coats).
   4. Finish Coat: Series 1074/1075, DFT 2.0 to 5.0 mils.
   5. Total DFT: 6 to 11 mils.
   6. Finish Color: As specified in Color Schedule.

2.13 ACCESSORIES

A. Coating Application Accessories:
   1. Accessories required for application of specified coatings in accordance with manufacturer's instructions, including thinners.
   2. Products of coating manufacturer.

2.14 PRIMERS/SEALERS

A. Interior Latex Primer/Sealer: White, pigmented, waterborne latex sealer used on new interior plaster, concrete and gypsum wallboard surfaces.
   1. Benjamin Moore; Regal First Coat Latex Primer/Undercoater No. 216.
   2. Coronado Paint; Super Kote 5000 Latex Primer-Sealer No. 40-11.
   3. Duron; Interior Acrylic Drywall Primer No. 04-124.
   4. Duron; Interior Acrylic Latex Undercoater No. 04-123.
   5. ICI Paints; Prep-N-Prime Interior Latex Wall Primer No. 1000-1200.
   6. PPG; Speedhide Int. Latex Primer Sealer No. 6-2.
   7. Sherwin-Williams; PrepRite 400 Interior Latex Primer No. B28W400.
   8. Or approved equal.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2.15 EPOXY PAINT

A. Epoxy Cold Cured Gloss: Solvent based, gloss, two component, epoxy/polyamide coating for wall and floor surfaces.
   1. Benjamin Moore; Polyamide Epoxy Coating No. CM36.
   2. Coronado Paint; Polyamide Epoxy Coating No. 101 Line.
   3. ICI Paints; Devoe/Fuller Guardcote No. DP34UXX.
   4. PPG; Aquapon Epoxy Cold Cured Gloss No. 95-1.
   5. Sherwin-Williams; Industrial & Marine Tile Clad High Solids No. B62WZ series.
   6. Or approved equal.

B. Interior/Exterior Epoxy W.B.: Waterborne, two component epoxy type, finish coating for prepared interior and exterior surfaces.
   1. Benjamin Moore; Acrylic Epoxy Gloss "A"; Hardener "B" No. M43/M44.
   2. Coronado Paint; Water-based Amine Adduct Epoxy No. 142 Line.
   3. ICI Paints; Devoe Coatings Tru-Glaze Acrylic Epoxy Coating No. 4418.
   4. PPG; Aquapon Waterborne Epoxy No. 98-1/98-98.
   5. Sherwin-Williams; Industrial & Marine Water Based Catalyzed Epoxy No. B70W Series.
   6. Or approved equal.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions under which coating systems are to be applied. Notify Engineer of areas or conditions not acceptable. Do not begin surface preparation or application until unacceptable areas or conditions have been corrected.

3.2 PROTECTION OF SURFACES NOT SCHEDULED TO BE COATED

A. Protect surrounding areas and surfaces not scheduled to be coated from damage during surface preparation and application of coatings.

B. Immediately remove coatings that fall on surrounding areas and surfaces not scheduled to be coated.

3.3 SURFACE PREPARATION OF STEEL

A. Prepare steel surfaces in accordance with coating manufacturer’s instructions.

B. Fabrication Defects:
   1. Correct steel and fabrication defects revealed by surface preparation.
   2. Remove weld spatter and slag.
   3. Round sharp edges and corners of welds to a smooth contour.
   4. Smooth weld undercuts and recesses.
   5. Grind down porous welds to pinhole-free metal.
   6. Remove weld flux from surface.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

C. Ensure surfaces are dry.

D. Immersed or Below Grade Surfaces: Remove visible oil, grease, dirt, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter in accordance with SSPC-SP 10/NACE 2.

E. Exterior Exposed or Interior Exposed Surfaces: Remove visible oil, grease, dirt, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter in accordance with SSPC-SP 6/NACE 3.

F. Interior or Immersed Surfaces, Severe Atmospheres: Remove visible oil, grease, dirt, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter in accordance with SSPC-SP 5/NACE 1.

G. Abrasive Blast-Cleaned Surfaces: Coat abrasive blast-cleaned surfaces with primer before visible rust forms on surface. Do not leave blast-cleaned surfaces uncoated for more than 8 hours.

H. Shop Primer: Prepare shop primer to receive field coat in accordance with manufacturer's instructions.

3.4 SURFACE PREPARATION OF GALVANIZED STEEL AND NONFERROUS METAL

A. Prepare galvanized steel and nonferrous metal surfaces in accordance with Manufacturer's instructions.

B. Ensure surfaces are dry.

C. Remove visible oil, grease, dirt, dust, protective mill coatings, and other soluble contaminants in accordance with SSPC-SP 1 or Manufacturer's instructions as specified for coating system.

D. Immersed Service: Clean surfaces by abrasive blasting.

E. Remove Rust From Galvanized Steel:
   1. Remove white rust from galvanized steel by hand or power brushing.
   2. Remove rust from old galvanized steel in accordance with SSPC-SP 2 or SP 3.
   3. Do not damage or remove galvanizing.

F. Increase mechanical adhesion under moderate to severe conditions, such as exterior exposure or chemical environments, by abrasive blast and/or chemical cleaning.

3.5 SURFACE PREPARATION OF DUCTILE OR CAST IRON

A. Prepare ductile or cast iron surfaces in accordance with Manufacturer's instructions.

B. Ensure surfaces are clean, dry, and free of oil, grease, dirt, dust, and other contaminants.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3.6 SURFACE PREPARATION OF PVC

A. Prepare PVC surfaces in accordance with Manufacturer's instructions.

B. Ensure surfaces are clean, dry, and free of oil, grease, dirt, dust, and other contaminants.

C. Scarify PVC surfaces.

3.7 SURFACE PREPARATION OF INSULATED PIPE

A. Prepare insulated pipe surfaces in accordance with Manufacturer's instructions.

B. Ensure surfaces are clean, dry, and free of oil, grease, dirt, dust, and other contaminants.

3.8 SURFACE PREPARATION OF CONCRETE

A. Interior, Exposed:
1. Prepare concrete surfaces in accordance with Manufacturer's instructions, SSPC-SP 13/NACE 6, and ICRI 03732.
2. Allow concrete to cure for a minimum of 28 days.
3. Test concrete for moisture in accordance with ASTM D 4263 and F 1869.
4. Shot-blast surface to remove laitance and solid contaminants and to provide clean, sound substrate with uniform anchor profile.
5. Fill holes, pits, voids, and cracks with Tnemec 63-1500 Filler and Surfacer.
6. Ensure surfaces are clean, dry, and free of oil, grease, chalk, form release agents, and other contaminants.

B. Exterior:
1. Prepare concrete surfaces in accordance with Manufacturer's instructions, SSPC-SP 13/NACE 6, and ICRI 03732.
2. Allow concrete to cure for a minimum of 14 days.
3. Test concrete for moisture in accordance with ASTM D 4263 and F 1869.
4. Level concrete protrusions and mortar spatter.
5. Fill hairline cracks less than 1/64 inch (0.4 mm) in accordance with Manufacturer's instructions.
6. Prepare cracks wider than 1/64 inch (0.4 mm), moving cracks, gaps, and expansion joints in accordance with Manufacturer's instructions.
7. Ensure surfaces are clean, dry, and free of oil, grease, chalk, form release agents, and other contaminants.

3.9 SURFACE PREPARATION OF CONCRETE FLOORS

A. Prepare concrete surfaces in accordance with Manufacturer's instructions, SSPC-SP 13/NACE 6, and ICRI 03732.

B. Ensure surfaces are clean, dry, and free of oil, grease, dirt, dust, and other contaminants.

C. Allow concrete to cure for a minimum of 28 days before coating.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

D. Test concrete for moisture in accordance with ASTM D 4263 and F 1869.

3.10 SURFACE PREPARATION OF SECONDARY CONTAINMENT

A. Prepare secondary containment surfaces in accordance with Manufacturer's instructions.

B. Prepare concrete surfaces in accordance with Manufacturer's instructions, SSPC-SP 13/NACE 6, and ICRI 03732.

C. Ensure surfaces are clean, dry, and free of oil, grease, dirt, dust, and other contaminants.

D. Allow concrete to cure for a minimum of 28 days before coating.

E. Test concrete for moisture in accordance with ASTM D 4263 and F 1869.

3.11 APPLICATION

A. Apply coatings in accordance with Manufacturer's instructions.

B. Mix and thin coatings, including multi-component materials, in accordance with manufacturer's instructions.

C. Keep containers closed when not in use to avoid contamination.

D. Do not use mixed coatings beyond pot life limits.

E. Use application equipment, tools, pressure settings, and techniques in accordance with Manufacturer's instructions.

F. Uniformly apply coatings at spreading rate required to achieve specified DFT.

G. Apply coatings to be free of film characteristics or defects that would adversely affect performance or appearance of coating systems.

H. Stripe paint with brush critical locations on steel such as welds, corners, and edges using specified primer.

3.12 REPAIR

A. Materials and Surfaces Not Scheduled To Be Coated: Repair or replace damaged materials and surfaces not scheduled to be coated.

B. Damaged Coatings: Touch-up or repair damaged coatings. Touch-up of minor damage shall be acceptable where result is not visibly different from adjacent surfaces. Recoat entire surface where touch-up result is visibly different, either in sheen, texture, or color.

C. Coating Defects: Repair in accordance with manufacturer's instructions coatings that exhibit film characteristics or defects that would adversely affect performance or appearance of coating systems.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3.13 FIELD QUALITY CONTROL

A. Applicator's Services:
   1. Verify coatings and other materials are as specified.
   2. Verify surface preparation and application are as specified.
   3. Verify DFT of each coat and total DFT of each coating system are as specified using wet film and dry film gauges.
   4. Coating Defects:
      a. Check coatings for film characteristics or defects that would adversely affect performance or appearance of coating systems.
      b. Check for holidays on interior steel immersion surfaces using holiday detector.
   5. Report: Submit daily written reports describing work performed, inspections made, and actions taken to correct nonconforming work. Daily reports shall contain, but not be limited to, the following information:
      a. Start date and time of work in each area.
      b. Weather conditions.
      c. Date and time of application for each following coat.
      d. Moisture content of substrate prior to each coat.
      e. Provisions utilized to maintain temperature and humidity of work area with Manufacturer's recommended ranges.
   6. Report nonconforming work not corrected.
   7. Submit copies of report to Engineer and Contractor.

B. Manufacturer's Field Services: Manufacturer's representative shall provide technical assistance and guidance for surface preparation and application of coating systems.

3.14 CLEANING

A. Remove temporary coverings and protection of surrounding areas and surfaces.

3.15 PROTECTION OF COATING SYSTEMS

A. Protect surfaces of coating systems from damage during construction.

3.16 ONE-YEAR INSPECTION

A. Owner will set date for one-year inspection of coating systems.

B. Inspection shall be attended by Owner, Contractor, Engineer, and Manufacturer's representative.

C. Repair deficiencies in coating systems as determined by Engineer in accordance with Manufacturers instructions.

3.17 PIPE CODING

A. All process piping shall be color-coded. Pipe color and band color, when required, shall be in accordance with the Color Schedule of this section.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Bands shall be spaced at maximum 6 feet on center. On pipe runs less than 6 feet in length, one band shall be located at the center of the run.
   1. Place bands:
      a. Along continuous lines.
      b. At changes in direction.
      c. At changes in elevation.
      d. On both sides of an obstruction.
   2. Band width shall be as follows:
      a. For pipes up to 8” in diameter: 2” minimum.
      b. For pipes 10” to 24” in diameter: 4” minimum.
      c. For pipes 30” to 48” in diameter: 6” minimum.
      d. For pipes greater than 48” in diameter: 8” minimum.

C. Pipe Labels:
   1. After painting of pipe work is completed, all pipe work shall have stenciled labels indicating the contents of the pipe (i.e. “WASTEWATER”).
   2. Labels shall be placed on each side of the pipe (180 degrees from each other) and spaced at maximum 20 feet on center. Labels shall be placed such that they are in direct line of site. For pipe runs less than 20 feet, label shall be placed at the center of the run or the most visible location. Label may be omitted from one side of pipe if view is obstructed from that side.
   3. When the flow in a pipe is in one direction at all times, flow direction arrows shall be placed in front of each label on the pipe.
   4. The width of each letter shall be 80% of the height of each letter. The height of each letter shall be as follows:
      a. For pipes 3/4" to 1-1/2” in diameter: 1/2” in height.
      b. For pipes 2” in diameter: 3/4” in height.
      c. For pipes 2-1/2” to 6” in diameter: 1-1/4” in height.
      d. For pipes 6” to 10” in diameter: 2-1/2” in height.
      e. For pipes greater than 10” in diameter: 3-1/2” in height.
   5. For pipes smaller than 3/4" in outside diameter, use a laminated plastic or aluminum tag with the lettering etched or stamped and filled in with black or contrasting enamel.
   6. Labels shall be black or white in color such that it is contrasting with the primary pipe color.

D. Equipment Labels:
   1. Where specified or directed by the Engineer, the Contractor shall label, in the same manner as the pipe, the individual units of equipment such as blowers, pumps, collector drives, compressors, silencers, etc. All push buttons, starters, switches, etc., when remote from the equipment, shall have labels of the engraved plastic type affixed to or adjacent to the remote switch, push button, starter, etc.

3.18 COLOR SCHEDULE

A. Piping:

Service	Pipe Color	Band Color
Wastewater	Gray	None
Raw Sludge	Brown	Black

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

Sludge Re-circulation (Suction)	Brown	Yellow
Sludge Draw-off	Brown	Orange
Sludge Re-circulation (Discharge)	Brown	None
Sludge Gas	Orange (or Red)	None
Natural Gas	Orange (or Red)	Black
Non-Potable Water	Blue	Black
Potable Water	Blue	None
Chlorine	Yellow	None
Sulfur Dioxide	Yellow	Red
Compressed Air	Green	None
Hot Water for Digester Heating	Blue	Red

B. OSHA Safety Colors

Service	**Color**
Fire Protection Equipment, Fire Boxes, Fire Extinguishers, Exit Signs, Fire Sprinkler Piping, Portable Containers of Flammable Liquid, Emergency Stop Bars.	Safety Red
Exposed Box Housings, Exposed Edges of Pulleys, Gears, Etc., Safety Starting Buttons.	Safety Orange
Unguarded Edges of Platforms, Elevated Door Edges, Bollards, Pulley Blocks, Material Handling Equipment.	Safety Yellow
First Aid Kits, First Aid Signs, First Aid Dispensaries, Drinking Water Stations	Safety Green

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

The "Protective Coatings - Supplement" forms a part of the Construction Documents and is attached.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

BGMU WWTP
Contract 3 – Biosolids System Addition
Coatings Coordination

	Metal		Concrete or Block					Specification Section
Item/Location	**Painted**	**Not Painted**	**Coated**	**Rubbed**	**Smooth Finish**	**Broom Finish**	**None**	
Pipe Bollards/Site	✔							Section 09 9911, Paragraph 2.6.A
Yard Hydrants/Site	✔							Section 09 9911, Paragraph 2.6.C
Natural Gas Piping – exterior/Site	✔ above	✔ below						Section 33 5113, Paragraph 2.3
Plant Water – exterior below grade/Site	✔ Mfg. Coating							Section 09 9911, Paragraph 2.6.C
Drain Piping – exterior below ground/Site		✔						Section 09 9911, Paragraph 2.8.E
Wet Cake Hoppers	-------- 304 SS ----------							
Live Bottom Twin Screws	-------- 304 SS ----------							
Process Piping – interior	✔							Section 09 9911, Paragraph 2.6.F
Process Piping – exterior	✔							Section 09 9911, Paragraph 2.6.F
Progressive Cavity Pumps	✔							Section 09 9911, Paragraph 2.8C
Air Piping – interior/Dryer Building	✔							Section 09 9911, Paragraph 2.7B
Indirect Biosolids Dryer/Dryer Building	✔	304 SS						Section 09 9911, Paragraph 2.6.D
Thermal Fluid Piping – interior	✔							Section 09 9911, Paragraph 2.9

BGMU WWTP
Contract 3 – Biosolids System Addition
Coatings Coordination

	Metal		Concrete or Block					Specification Section
Item/Location	**Painted**	**Not Painted**	**Coated**	**Rubbed**	**Smooth Finish**	**Broom Finish**	**None**	
Silos - Interior and Exterior	✔							Section 09 9911, Paragraph 2.6.A&B
Bag House - Exterior	✔							Section 09 9911, Paragraph 2.6A
Bag House - Interior	✔							Section 09 9911, Paragraph 2.6B
Plant Water Piping – interior	✔							Section 09 9911, Paragraph 2.6.C
Nitrogen Gas Piping – interior	✔							Section 09 9911, Paragraph 2.7.B
Nitrogen Gas Piping – exterior	✔							Section 09 9911, Paragraph 2.7.A
Natural Gas Piping – interior	✔							Section 23 1123, Paragraph 3.10
Pneumatic Piping – interior	------304 SS-----							
Pneumatic Piping – exterior above grade	-----304 SS-----							
Drain Piping – interior below ground/Dryer Building	✔ Mfg. Coating							Section 09 9911, Paragraph 2.8.E
Odor Control Piping – Interior and Exterior	✔							Section 09 9911, Paragraph 2.12
HVAC piping and ducting – interior	✔							Section 09 9911, Paragraph 2.8.C
Potable Water – interior/Dryer Building	✔							Section 09 9911, Paragraph 2.8.C

BGMU WWTP
Contract 3 – Biosolids System Addition
Coatings Coordination

	Metal		Concrete or Block					Specification Section
Item/Location	**Painted**	**Not Painted**	**Coated**	**Rubbed**	**Smooth Finish**	**Broom Finish**	**None**	
Dryer Building – exterior			✔ Block	✔ Parapet				Section 09 9911, Paragraph 2.10.A
Dryer Building - floor slab & concrete stairs					✔			Section 09 9911, Paragraph 2.11
CMU Wall - Interior					✔			Section 09 9911, Paragraph 2.10.D

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
1. Piping materials and installation instructions common to most piping systems.
2. Transition fittings.
3. Dielectric fittings.
4. Mechanical sleeve seals.
5. Sleeves.
6. Escutcheons.
7. Grout.
8. Plumbing demolition.
9. Equipment installation requirements common to equipment sections.
10. Painting and finishing.
11. Concrete bases.
12. Supports and anchorages.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for plastic materials:
1. ABS: Acrylonitrile-butadiene-styrene plastic.
2. CPVC: Chlorinated polyvinyl chloride plastic.
3. PE: Polyethylene plastic.
4. PVC: Polyvinyl chloride plastic.

G. The following are industry abbreviations for rubber materials:
1. EPDM: Ethylene-propylene-diene terpolymer rubber.
2. NBR: Acrylonitrile-butadiene rubber.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1.4 SUBMITTALS

A. Product Data: For the following:
   1. Transition fittings.
   2. Dielectric fittings.
   3. Mechanical sleeve seals.
   4. Escutcheons.

B. Welding certificates.

1.5 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
   1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
   2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.7 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for plumbing installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for plumbing items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in another Division and on the Drawings.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 22 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

A. Refer to individual Division 22 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
   1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.
      a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
      b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
   2. AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

H. Solvent Cements for Joining Plastic Piping:
   1. CPVC Piping: ASTM F 493.
   2. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

I. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2.4 TRANSITION FITTINGS

A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.
   1. Manufacturers:
      a. Cascade Waterworks Mfg. Co.
      b. Dresser Industries, Inc.; DMD Div.
      c. Or approved equal.
   2. Underground Piping NPS 1-1/2 (DN 40) and Smaller: Manufactured fitting or coupling.
   3. Underground Piping NPS 2 (DN 50) and Larger: AWWA C219, metal sleeve-type coupling.
   4. Aboveground Pressure Piping: Pipe fitting.

B. Plastic-to-Metal Transition Fittings: PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
   1. Manufacturers:
      a. Eslon Thermoplastics.
      b. Or approved equal.

C. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
   1. Manufacturers:
      a. Thompson Plastics, Inc.
      b. Or approved equal.

D. Plastic-to-Metal Transition Unions: MSS SP-107, PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.
   1. Manufacturers:
      a. NIBCO INC.
      b. NIBCO, Inc.; Chemtrol Div.
      c. Or approved equal.

E. Flexible Transition Couplings for Underground Nonpressure Drainage Piping: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.
   1. Manufacturers:
      a. Cascade Waterworks Mfg. Co.
      b. Fernco, Inc.
      c. Mission Rubber Company.
      d. Plastic Oddities, Inc.
      e. Or approved equal.

2.5 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig (1725-kPa) minimum working pressure at 180 deg F (82 deg C).
   1. Manufacturers:
      a. Epco Sales, Inc.
      b. Watts Industries, Inc.; Water Products Div.
      c. Zurn Industries, Inc.; Wilkins Div.
      d. Or approved equal.

D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig (1035- or 2070-kPa) minimum working pressure as required to suit system pressures.
   1. Manufacturers:
      a. Epco Sales, Inc.
      b. Watts Industries, Inc.; Water Products Div.
      c. Or approved equal.

E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
   1. Manufacturers:
      a. Calpico, Inc.
      b. Pipeline Seal and Insulator, Inc.
      c. Or approved equal.
   2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig (1035- or 2070-kPa) minimum working pressure where required to suit system pressures.

F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).
   1. Manufacturers:
      a. Calpico, Inc.
      b. Lochinvar Corp.
      c. Or approved equal.

G. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).
   1. Manufacturers:
      a. Precision Plumbing Products, Inc.
      b. Sioux Chief Manufacturing Co., Inc.
      c. Victaulic Co. of America.
      d. Or approved equal.

2.6 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
   1. Manufacturers:
      a. Calpico, Inc.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

b. Metraflex Co.
c. Pipeline Seal and Insulator, Inc.
d. Or approved equal.

2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
3. Pressure Plates: Stainless steel. Include two for each sealing element.
4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.7 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.

B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
1. Underdeck Clamp: Clamping ring with set screws.

E. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

2.8 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Cast-Brass Type: With set screw.
1. Finish: Polished chrome-plated.

D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
1. Finish: Polished chrome-plated.

E. One-Piece, Stamped-Steel Type: With spring clips and chrome-plated finish.

F. One-Piece, Floor-Plate Type: Cast-iron floor plate.

G. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2.9 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
   1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
   2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
   3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 PLUMBING DEMOLITION

A. Refer to other Divisions and Drawings for general demolition requirements and procedures.

B. Disconnect, demolish, and remove plumbing systems, equipment, and components indicated to be removed.
   1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
   2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
   3. Equipment to Be Removed: Disconnect and cap services and remove equipment.
   4. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
   5. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 22 Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Install piping to allow application of insulation.

K. Select system components with pressure rating equal to or greater than system operating pressure.

L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
   1. New Piping:
      a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
      b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
      c. Insulated Piping: One-piece, stamped-steel type with spring clips.
      d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
      e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
      f. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished chrome-plated finish.
      g. Bare Piping in Equipment Rooms: One-piece, cast-brass type.
      h. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
   2. Existing Piping: Use the following:
      a. Chrome-Plated Piping: Split-casting, cast-brass type with chrome-plated finish.
      b. Insulated Piping: Split-plate, stamped-steel type with concealed hinge and spring clips.
      c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.
      d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.
      e. Bare Piping in Unfinished Service Spaces: Split-casting, cast-brass type with polished chrome-plated finish.
      f. Bare Piping in Equipment Rooms: Split-casting, cast-brass type.
      g. Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting, floor-plate type.

M. Sleeves are not required for core-drilled holes.

N. Permanent sleeves are not required for holes formed by removable PE sleeves.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

O. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
   1. Cut sleeves to length for mounting flush with both surfaces.
      a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
   2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
   3. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
      a. Steel Pipe Sleeves: For pipes smaller than NPS 6 (DN 150).
      b. Steel Sheet Sleeves: For pipes NPS 6 (DN 150) and larger, penetrating gypsum-board partitions.
      c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level.
         1) Seal space outside of sleeve fittings with grout.
   4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint and in coordination with all firestop requirements.

P. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
   1. Install steel pipe for sleeves smaller than 6 inches (150 mm) in diameter.
   2. Install cast-iron "wall pipes" for sleeves 6 inches (150 mm) and larger in diameter.
   3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

Q. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
   1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

R. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials.

S. Verify final equipment locations for roughing-in.

T. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3.3 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 22 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
   1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
   2. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
   3. PVC Nonpressure Piping: Join according to ASTM D 2855.

J. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.

K. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.

L. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
   1. Plain-End Pipe and Fittings: Use butt fusion.
   2. Plain-End Pipe and Socket Fittings: Use socket fusion.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

M. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

3.4 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:
1. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.
3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.5 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install plumbing equipment to facilitate service, maintenance, and repair or replace-ment of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

3.6 PAINTING

A. Painting of plumbing systems, equipment, and components is specified in Division 09 Sections "Interior Painting" and "Exterior Painting."

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.7 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
1. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of the base.
3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
7. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete and reinforcement as specified in Division 03.

3.8 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 05 Section "Metal Fabrications" for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor plumbing materials and equipment.

C. Field Welding: Comply with AWS D1.1.

3.9 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor plumbing materials and equipment.

B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.

C. Attach to substrates as required to support applied loads.

3.10 GROUTING

A. Mix and install grout for plumbing equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
1. Bronze angle valves.
2. Brass ball valves.
3. Bronze ball valves.
4. Iron ball valves.
5. Iron, single-flange butterfly valves.
6. Iron, grooved-end butterfly valves.
7. Bronze lift check valves.
8. Bronze swing check valves.
9. Iron swing check valves.
10. Iron swing check valves with closure control.
11. Iron, grooved-end swing check valves.
12. Iron, center-guided check valves.
13. Iron, plate-type check valves.
14. Bronze gate valves.
15. Iron gate valves.
16. Bronze globe valves.
17. Iron globe valves.
18. Lubricated plug valves.
19. Chainwheels.

B. Related Sections:
1. Division 22 plumbing piping Sections for specialty valves applicable to those Sections only.
2. Division 22 Section "Identification for Plumbing Piping and Equipment" for valve tags and schedules.
3. Division 33 and Division 44 Sections for general-duty and specialty valves for site construction piping.

1.3 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene copolymer rubber.

C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

D. NRS: Nonrising stem.

E. OS&Y: Outside screw and yoke.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

F. RS: Rising stem.

1.4 SUBMITTALS

A. Product Data: For each type of valve indicated.

1.5 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:
1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
2. ASME B31.1 for power piping valves.
3. ASME B31.9 for building services piping valves.

C. NSF Compliance: NSF 61 for valve materials for potable-water service.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set angle, gate, and globe valves closed to prevent rattling.
4. Set ball and plug valves open to minimize exposure of functional surfaces.
5. Set butterfly valves closed or slightly open.
6. Block check valves in either closed or open position.

B. Use the following precautions during storage:
1. Maintain valve end protection.
2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Refer to valve schedule articles for applications of valves.

B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

C. Valve Sizes: Same as upstream piping unless otherwise indicated.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

D. Valve Actuator Types:
   1. Gear Actuator: For quarter-turn valves NPS 8 (DN 200) and larger.
   2. Handwheel: For valves other than quarter-turn types.
   3. Handlever: For quarter-turn valves NPS 6 (DN 150) and smaller.
   4. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 10 plug valves, for each size square plug-valve head.
   5. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.

E. Valves in Insulated Piping: With 2-inch (50-mm) stem extensions and the following features:
   1. Gate Valves: With rising stem.
   2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
   3. Butterfly Valves: With extended neck.

F. Valve-End Connections:
   1. Flanged: With flanges according to ASME B16.1 for iron valves.
   2. Grooved: With grooves according to AWWA C606.
   3. Solder Joint: With sockets according to ASME B16.18.
   4. Threaded: With threads according to ASME B1.20.1.

G. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRASS BALL VALVES

A. Two-Piece, Full-Port, Brass Ball Valves with Brass Trim:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Crane Co.; Crane Valve Group; Crane Valves.
      b. Crane Co.; Crane Valve Group; Jenkins Valves.
      c. Hammond Valve.
      d. Jamesbury; a subsidiary of Metso Automation.
      e. Kitz Corporation.
      f. Milwaukee Valve Company.
      g. NIBCO INC.
      h. Red-White Valve Corporation.
      i. Or approved equal.
   2. Description:
      a. Standard: MSS SP-110.
      b. SWP Rating: 150 psig (1035 kPa).
      c. CWP Rating: 600 psig (4140 kPa).
      d. Body Design: Two piece.
      e. Body Material: Forged brass.
      f. Ends: Threaded.
      g. Seats: PTFE or TFE.
      h. Stem: Brass.
      i. Solid Ball: Chrome-plated brass.
      j. Port: Full.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Two-Piece, Regular-Port, Brass Ball Valves with Brass Trim:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Hammond Valve.
      b. Jamesbury; a subsidiary of Metso Automation.
      c. Milwaukee Valve Company.
      d. Or approved equal.
   2. Description:
      a. Standard: MSS SP-110.
      b. SWP Rating: 150 psig (1035 kPa).
      c. CWP Rating: 600 psig (4140 kPa).
      d. Body Design: Two piece.
      e. Body Material: Forged brass.
      f. Ends: Threaded.
      g. Seats: PTFE or TFE.
      h. Stem: Brass.
      i. Ball: Chrome-plated brass.
      j. Port: Regular.

2.3 BRONZE BALL VALVES

A. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Conbraco Industries, Inc.; Apollo Valves.
      b. Crane Co.; Crane Valve Group; Crane Valves.
      c. Hammond Valve.
      d. Milwaukee Valve Company.
      e. NIBCO INC.
      f. Red-White Valve Corporation.
      g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
      h. Or approved equal.
   2. Description:
      a. Standard: MSS SP-110.
      b. SWP Rating: 150 psig (1035 kPa).
      c. CWP Rating: 600 psig (4140 kPa).
      d. Body Design: Two piece.
      e. Body Material: Bronze.
      f. Ends: Threaded.
      g. Seats: PTFE or TFE.
      h. Stem: Bronze.
      i. Solid Ball: Chrome-plated brass.
      j. Port: Full.

B. Two-Piece, Regular-Port, Bronze Ball Valves with Bronze Trim:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

a. Conbraco Industries, Inc.; Apollo Valves.
b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. Crane Co.; Crane Valve Group; Stockham Division.
d. Hammond Valve.
e. Milwaukee Valve Company.
f. NIBCO INC.
g. Or approved equal.

2. Description:
a. Standard: MSS SP-110.
b. SWP Rating: 150 psig (1035 kPa).
c. CWP Rating: 600 psig (4140 kPa).
d. Body Design: Two piece.
e. Body Material: Bronze.
f. Ends: Threaded.
g. Seats: PTFE or TFE.
h. Stem: Bronze.
i. Ball: Chrome-plated brass.
j. Port: Regular.

2.4 IRON BALL VALVES

A. Class 125, Iron Ball Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Conbraco Industries, Inc.; Apollo Valves.
b. Kitz Corporation.
c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
d. Or approved equal.
2. Description:
a. Standard: MSS SP-72.
b. CWP Rating: 200 psig (1380 kPa).
c. Body Design: Split body.
d. Body Material: ASTM A 126, gray iron.
e. Ends: Flanged.
f. Seats: PTFE or TFE.
g. Stem: Stainless steel.
h. Solid Ball: Stainless steel.
i. Port: Full.

2.5 IRON, SINGLE-FLANGE BUTTERFLY VALVES

A. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Aluminum-Bronze Disc:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Conbraco Industries, Inc.; Apollo Valves.
b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. Crane Co.; Crane Valve Group; Stockham Division.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

d. Hammond Valve.
e. Kitz Corporation.
f. Milwaukee Valve Company.
g. NIBCO INC.
h. Red-White Valve Corporation.
i. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
j. Or approved equal.

2. Description:
   a. Standard: MSS SP-67, Type I.
   b. CWP Rating: 200 psig (1380 kPa).
   c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
   d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
   e. Seat: EPDM.
   f. Stem: One- or two-piece stainless steel.
   g. Disc: Aluminum bronze.

2.6 IRON, GROOVED-END BUTTERFLY VALVES

A. 175 CWP, Iron, Grooved-End Butterfly Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Kennedy Valve; a division of McWane, Inc.
      b. Tyco Fire Products LP; Grinnell Mechanical Products.
      c. Victaulic Company.
      d. Or approved equal.
   2. Description:
      a. Standard: MSS SP-67, Type I.
      b. CWP Rating: 175 psig (1200 kPa).
      c. Body Material: Coated, ductile iron.
      d. Stem: Two-piece stainless steel.
      e. Disc: Coated, ductile iron.
      f. Seal: EPDM.

B. 300 CWP, Iron, Grooved-End Butterfly Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Kennedy Valve; a division of McWane, Inc.
      b. Mueller Steam Specialty; a division of SPX Corporation.
      c. NIBCO INC.
      d. Tyco Fire Products LP; Grinnell Mechanical Products.
      e. Victaulic Company.
      f. Or approved equal.
   2. Description:
      a. Standard: MSS SP-67, Type I.
      b. NPS 8 (DN 200) and Smaller CWP Rating: 300 psig (2070 kPa).
      c. NPS 10 (DN 250) and Larger CWP Rating: 200 psig (1380 kPa).

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

d. Body Material: Coated, ductile iron.
e. Stem: Two-piece stainless steel.
f. Disc: Coated, ductile iron.
g. Seal: EPDM.

2.7 BRONZE SWING CHECK VALVES

A. Class 125, Bronze Swing Check Valves with Bronze Disc:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. Crane Co.; Crane Valve Group; Stockham Division.
d. Hammond Valve.
e. Kitz Corporation.
f. Milwaukee Valve Company.
g. NIBCO INC.
h. Red-White Valve Corporation.
i. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
j. Or approved equal.
2. Description:
a. Standard: MSS SP-80, Type 3.
b. CWP Rating: 200 psig (1380 kPa).
c. Body Design: Horizontal flow.
d. Body Material: ASTM B 62, bronze.
e. Ends: Threaded.
f. Disc: Bronze.

B. Class 150, Bronze Swing Check Valves with Bronze Disc:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. Crane Co.; Crane Valve Group; Stockham Division.
d. Kitz Corporation.
e. Milwaukee Valve Company.
f. NIBCO INC.
g. Red-White Valve Corporation.
h. Or approved equal.
2. Description:
a. Standard: MSS SP-80, Type 3.
b. CWP Rating: 300 psig (2070 kPa).
c. Body Design: Horizontal flow.
d. Body Material: ASTM B 62, bronze.
e. Ends: Threaded.
f. Disc: Bronze.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2.8 IRON SWING CHECK VALVES

A. Class 125, Iron Swing Check Valves with Metal Seats:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Crane Co.; Crane Valve Group; Crane Valves.
      b. Crane Co.; Crane Valve Group; Jenkins Valves.
      c. Crane Co.; Crane Valve Group; Stockham Division.
      d. Hammond Valve.
      e. Kitz Corporation.
      f. Milwaukee Valve Company.
      g. NIBCO INC.
      h. Red-White Valve Corporation.
      i. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
      j. Or approved equal.
   2. Description:
      a. Standard: MSS SP-71, Type I.
      b. CWP Rating: 200 psig (1380 kPa).
      c. Body Design: Clear or full waterway.
      d. Body Material: ASTM A 126, gray iron with bolted bonnet.
      e. Ends: Flanged.
      f. Trim: Bronze.
      g. Gasket: Asbestos free.

B. Class 250, Iron Swing Check Valves with Metal Seats:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Crane Co.; Crane Valve Group; Crane Valves.
      b. Crane Co.; Crane Valve Group; Jenkins Valves.
      c. Crane Co.; Crane Valve Group; Stockham Division.
      d. Hammond Valve.
      e. Milwaukee Valve Company.
      f. NIBCO INC.
      g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
      h. Or approved equal.
   2. Description:
      a. Standard: MSS SP-71, Type I.
      b. CWP Rating: 500 psig (3450 kPa).
      c. Body Design: Clear or full waterway.
      d. Body Material: ASTM A 126, gray iron with bolted bonnet.
      e. Ends: Flanged.
      f. Trim: Bronze.
      g. Gasket: Asbestos free.

2.9 IRON SWING CHECK VALVES WITH CLOSURE CONTROL

A. Class 125, Iron Swing Check Valves with Lever- and Weight-Closure Control:

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Crane Co.; Crane Valve Group; Crane Valves.
   b. Crane Co.; Crane Valve Group; Jenkins Valves.
   c. Crane Co.; Crane Valve Group; Stockham Division.
   d. Hammond Valve.
   e. Milwaukee Valve Company.
   f. NIBCO INC.
   g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   h. Or approved equal.
2. Description:
   a. Standard: MSS SP-71, Type I.
   b. CWP Rating: 200 psig (1380 kPa).
   c. Body Design: Clear or full waterway.
   d. Body Material: ASTM A 126, gray iron with bolted bonnet.
   e. Ends: Flanged.
   f. Trim: Bronze.
   g. Gasket: Asbestos free.
   h. Closure Control: Factory-installed, exterior lever and weight.

2.10 BRONZE GATE VALVES

A. Class 125, NRS Bronze Gate Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Crane Co.; Crane Valve Group; Crane Valves.
   b. Crane Co.; Crane Valve Group; Jenkins Valves.
   c. Crane Co.; Crane Valve Group; Stockham Division.
   d. Hammond Valve.
   e. Kitz Corporation.
   f. Milwaukee Valve Company.
   g. NIBCO INC.
   h. Red-White Valve Corporation.
   i. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   j. Or approved equal.
2. Description:
   a. Standard: MSS SP-80, Type 1.
   b. CWP Rating: 200 psig (1380 kPa).
   c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
   d. Ends: Threaded or solder joint.
   e. Stem: Bronze.
   f. Disc: Solid wedge; bronze.
   g. Packing: Asbestos free.
   h. Handwheel: Malleable iron.

B. Class 150, NRS Bronze Gate Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

a. Hammond Valve.
b. Kitz Corporation.
c. Milwaukee Valve Company.
d. NIBCO INC.
e. Red-White Valve Corporation.
f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
g. Or approved equal.

2. Description:
a. Standard: MSS SP-80, Type 1.
b. CWP Rating: 300 psig (2070 kPa).
c. Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
d. Ends: Threaded.
e. Stem: Bronze.
f. Disc: Solid wedge; bronze.
g. Packing: Asbestos free.
h. Handwheel: Malleable iron.

2.11 IRON GATE VALVES

A. Class 125, NRS, Iron Gate Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. Crane Co.; Crane Valve Group; Stockham Division.
d. Hammond Valve.
e. Kitz Corporation.
f. Milwaukee Valve Company.
g. NIBCO INC.
h. Red-White Valve Corporation.
i. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
j. Or approved equal.
2. Description:
a. Standard: MSS SP-70, Type I.
b. CWP Rating: 200 psig (1380 kPa).
c. Body Material: ASTM A 126, gray iron with bolted bonnet.
d. Ends: Flanged.
e. Trim: Bronze.
f. Disc: Solid wedge.
g. Packing and Gasket: Asbestos free.

B. Class 250, NRS, Iron Gate Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Stockham Division.
c. NIBCO INC.
d. Or approved equal.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2. Description:
   a. Standard: MSS SP-70, Type I.
   b. CWP Rating: 500 psig (3450 kPa).
   c. Body Material: ASTM A 126, gray iron with bolted bonnet.
   d. Ends: Flanged.
   e. Trim: Bronze.
   f. Disc: Solid wedge.
   g. Packing and Gasket: Asbestos free.

2.12 BRONZE GLOBE VALVES

A. Class 125, Bronze Globe Valves with Bronze Disc:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Crane Co.; Crane Valve Group; Crane Valves.
   b. Crane Co.; Crane Valve Group; Stockham Division.
   c. Hammond Valve.
   d. Kitz Corporation.
   e. Milwaukee Valve Company.
   f. NIBCO INC.
   g. Red-White Valve Corporation.
   h. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   i. Or approved equal.
2. Description:
   a. Standard: MSS SP-80, Type 1.
   b. CWP Rating: 200 psig (1380 kPa).
   c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
   d. Ends: Threaded or solder joint.
   e. Stem and Disc: Bronze.
   f. Packing: Asbestos free.
   g. Handwheel: Malleable iron.

2.13 MUD VALVES

A. See Division 40 Section "Process Valves" for detailed mud valve specifications.

2.14 CHAINWHEELS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Babbitt Steam Specialty Co.
2. Roto Hammer Industries.
   a. Trumbull Industries.
   b. Or approved equal.

B. Description: Valve actuation assembly with sprocket rim, brackets, and chain.
1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
2. Attachment: For connection to ball and butterfly valve stems.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3. Sprocket Rim with Chain Guides: Ductile iron, of type and size required for valve. Include zinc coating.
4. Chain: Galvanized steel, of size required to fit sprocket rim.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install chainwheels on operators for ball, butterfly, gate, globe, and plug valves NPS 4 (DN 100) and larger and more than 96 inches (2400 mm) above floor. Extend chains to 60 inches (1520 mm) above finished floor.

F. Install check valves for proper direction of flow and as follows:
1. Swing Check Valves: In horizontal position with hinge pin level.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:
   1. Shutoff Service: Ball, butterfly, gate, or plug valves.
   2. Butterfly Valve Dead-End Service: Single-flange (lug) type.
   3. Throttling Service: Globe or ball valves.
   4. Pump-Discharge Check Valves:
      a. NPS 2 (DN 50) and Smaller: Bronze swing check valves with bronze disc.
      b. NPS 2-1/2 (DN 65) and Larger for Domestic Water: Iron swing check valves with lever and weight or with spring or iron, center-guided, resilient-seat check valves.
      c. NPS 2-1/2 (DN 65) and Larger for Sanitary Waste and Storm Drainage: Iron swing check valves with lever and weight or spring.

B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.

C. Select valves, except wafer types, with the following end connections:
   1. For Copper Tubing, NPS 2 (DN 50) and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
   2. For Copper Tubing, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules below.
   3. For Copper Tubing, NPS 5 (DN 125) and Larger: Flanged ends.
   4. For Steel Piping, NPS 2 (DN 50) and Smaller: Threaded ends.
   5. For Steel Piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules below.
   6. For Steel Piping, NPS 5 (DN 125) and Larger: Flanged ends.
   7. For Grooved-End Copper Tubing and Steel Piping: Valve ends may be grooved.

3.5 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:
   1. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
   2. Ball Valves: Two piece, full port, brass or bronze with brass or bronze trim.
   3. Bronze Swing Check Valves: Class 125, bronze disc.
   4. Bronze Globe Valves: Class 125, bronze disc.

B. Pipe NPS 2-1/2 (DN 65) and Larger:
   1. Iron Valves, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): May be provided with threaded ends instead of flanged ends.
   2. Iron Ball Valves: Class 150.
   3. Iron, Single-Flange Butterfly Valves: 200 CWP, EPDM seat, aluminum-bronze disc.
   4. Iron, Grooved-End Butterfly Valves: 300 CWP.
   5. Iron Swing Check Valves: Class 125, metal seats.
   6. Iron Gate Valves: Class 125, NRS.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3.6 SANITARY-WASTE VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:
   1. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
   2. Ball Valves: Two piece, full port, brass or bronze with brass or bronze trim.
   3. Bronze Swing Check Valves: Class 125, bronze disc.
   4. Bronze Gate Valves: Class 125, NRS.

B. Pipe NPS 2-1/2 (DN 65) and Larger:
   1. Iron Valves, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): May be provided with threaded ends instead of flanged ends.
   2. Iron Ball Valves: Class 150.
   3. Iron Swing Check Valves: Class 125, metal seats.
   4. Iron Swing Check Valves with Closure Control: Class 125, lever and weight.
   5. Iron Gate Valves: Class 125, NRS.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following hangers and supports for plumbing system piping and equipment:
   1. Steel pipe hangers and supports.
   2. Trapeze pipe hangers.
   3. Metal framing systems.
   4. Thermal-hanger shield inserts.
   5. Fastener systems.
   6. Pipe stands.
   7. Pipe positioning systems.
   8. Equipment supports.

B. Related Sections include the following:
   1. Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment" for vibration isolation devices.

1.3 DEFINITIONS

A. MSS: Manufacturers Standardization Society for The Valve and Fittings Industry Inc.

B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.4 PERFORMANCE REQUIREMENTS

A. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.5 SUBMITTALS

A. Product Data: For the following:
   1. Steel pipe hangers and supports.
   2. Thermal-hanger shield inserts.
   3. Powder-actuated fastener systems.
   4. Pipe positioning systems.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Shop Drawings: Signed and sealed by a qualified Professional Engineer. For any non-manufactured system, show fabrication and installation details and include calculations for the following:
   1. Trapeze pipe hangers. Include Product Data for components.
   2. Metal framing systems. Include Product Data for components.
   3. Pipe stands. Include Product Data for components.
   4. Equipment supports.

C. Welding certificates.

1.6 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to the following:
   1. AWS D1.1, "Structural Welding Code--Steel."
   2. AWS D1.4, "Structural Welding Code--Reinforcing Steel."
   3. ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 STEEL PIPE HANGERS AND SUPPORTS

A. Description: MSS SP-58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.

B. Manufacturers:
   1. B-Line Systems, Inc.; a division of Cooper Industries.
   2. ERICO/Michigan Hanger Co.
   3. Grinnell Corp.
   4. PHD Manufacturing, Inc.
   5. PHS Industries, Inc.
   6. Tolco Inc.
   7. Or approved equal.

C. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.3 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2.4 METAL FRAMING SYSTEMS

A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.

B. Manufacturers:
1. B-Line Systems, Inc.; a division of Cooper Industries.
2. ERICO/Michigan Hanger Co.; ERISTRUT Div.
3. Power-Strut Div.; Tyco International, Ltd.
4. Thomas & Betts Corporation.
5. Tolco Inc.
6. Unistrut Corp.; Tyco International, Ltd.
7. Or approved equal.

C. Coatings: Manufacturer's standard finish unless bare metal surfaces are indicated.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.5 THERMAL-HANGER SHIELD INSERTS

A. Description: 100-psig- (690-kPa-) minimum, compressive-strength insulation insert encased in sheet metal shield.

B. Manufacturers:
1. ERICO/Michigan Hanger Co.
2. PHS Industries, Inc.
3. Pipe Shields, Inc.
4. Or approved equal.

C. Insulation-Insert Material for Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass. Furnish complete with vapor barrier for cold piping.

D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

F. Insert Length: Extend 2 inches (50 mm) beyond sheet metal shield for piping operating below ambient air temperature.

2.6 FASTENER SYSTEMS

A. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
1. Manufacturers:
   a. B-Line Systems, Inc.; a division of Cooper Industries.
   b. Hilti, Inc.
   c. ITW Ramset/Red Head.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

d. Powers Fasteners.
e. Or approved equal.

2.7 PIPE STAND FABRICATION

A. Pipe Stands, General: Shop or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

B. Compact Pipe Stand: One-piece plastic unit with integral-rod-roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
1. Manufacturers:
   a. ERICO/Michigan Hanger Co.
   b. MIRO Industries.
   c. Or approved equal.

C. Low-Type, Single-Pipe Stand: One-piece plastic base unit with plastic roller, for roof installation without membrane penetration.
1. Manufacturers:
   a. MIRO Industries.
   b. Or approved equal.

D. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe support made from structural-steel shape, continuous-thread rods, and rollers for mounting on permanent stationary roof curb.

2.8 PIPE POSITIONING SYSTEMS

A. Description: IAPMO PS 42, system of metal brackets, clips, and straps for positioning piping in pipe spaces for plumbing fixtures for commercial applications.

B. Manufacturers:
1. C & S Mfg. Corp.
2. HOLDRITE Corp.; Hubbard Enterprises.
3. Or approved equal.

2.9 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.

2.10 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30 (DN 15 to DN 750).
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F (49 to 232 deg C) pipes, NPS 4 to NPS 16 (DN 100 to DN 400), requiring up to 4 inches (100 mm) of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24 (DN 20 to DN 600), requiring clamp flexibility and up to 4 inches (100 mm) of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24 (DN 15 to DN 600), if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4 (DN 15 to DN 100), to allow off-center closure for hanger installation before pipe erection.
6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated stationary pipes, NPS 3/4 to NPS 8 (DN 20 to DN 200).
7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8 (DN 15 to DN 200).
8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8 (DN 15 to DN 200).
9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 2 (DN 15 to DN 50).
10. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 8 (DN 10 to DN 200).
11. Extension Hinged or 2-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 3 (DN 10 to DN 80).
12. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30 (DN 15 to DN 750).
13. Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36 (DN 100 to DN 900), with steel pipe base stanchion support and cast-iron floor flange and with U-bolt to retain pipe.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

14. Adjustable, Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes, NPS 2-1/2 to NPS 36 (DN 65 to DN 900), if vertical adjustment is required, with steel pipe base stanchion support and cast-iron floor flange.
15. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20 (DN 65 to DN 500), from single rod if horizontal movement caused by expansion and contraction might occur.
16. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42 (DN 50 to DN 1050), if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
17. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes, NPS 2 to NPS 30 (DN 50 to DN 750), if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

F. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20 (DN 20 to DN 500).
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20 (DN 20 to DN 500), if longer ends are required for riser clamps.

G. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches (150 mm) for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F (49 to 232 deg C) piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F (49 to 232 deg C) piping installations.

H. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. C-Clamps (MSS Type 23): For structural shapes.
6. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
7. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
8. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

9. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
10. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
11. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:
    a. Light (MSS Type 31): 750 lb (340 kg).
    b. Medium (MSS Type 32): 1500 lb (680 kg).
    c. Heavy (MSS Type 33): 3000 lb (1360 kg).

I. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

J. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches (32 mm).

K. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.

L. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.

M. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

N. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

3.2 HANGER AND SUPPORT INSTALLATION

A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.
1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.

D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

E. Fastener System Installation:
   1. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

F. Pipe Stand Installation:
   1. Pipe Stand Types except Curb-Mounting Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
   2. Curb-Mounting-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. Refer to Division 07 Section "Roof Accessories" for curbs.

G. Pipe Positioning System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture. Refer to Division 22 Section "Plumbing Fixtures" for plumbing fixtures.

H. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.

I. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

J. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

K. Install lateral bracing with pipe hangers and supports to prevent swaying.

L. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 (DN 65) and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

M. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

N. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9 (for building services piping) are not exceeded.

O. Insulated Piping: Comply with the following:
   1. Attach clamps and spacers to piping.
      a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
      b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

c. Do not exceed pipe stress limits according to ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.
3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.
4. Shield Dimensions for Pipe: Not less than the following:
   a. NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.
   b. NPS 4 (DN 100): 12 inches (305 mm) long and 0.06 inch (1.52 mm) thick.
   c. NPS 5 and NPS 6 (DN 125 and DN 150): 18 inches (457 mm) long and 0.06 inch (1.52 mm) thick.
   d. NPS 8 to NPS 14 (DN 200 to DN 350): 24 inches (610 mm) long and 0.075 inch (1.91 mm) thick.
5. Pipes NPS 8 (DN 200) and Larger: Include wood inserts.
6. Insert Material: Length at least as long as protective shield.
7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor as indicated on the Drawings or other Divisions.

B. Grouting: Place grout under supports for equipment and make smooth bearing surface.

C. Provide lateral bracing, to prevent swaying, for equipment supports as required by Local Seismic Ratings and AHJ.

3.4 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches (40 mm).

3.6 PAINTING

A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
   1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
1. Isolation pads.
2. Isolation mounts.
3. Restrained elastomeric isolation mounts.
4. Freestanding and restrained spring isolators.
5. Housed spring mounts.
6. Elastomeric hangers.
7. Spring hangers.
8. Spring hangers with vertical-limit stops.
9. Pipe riser resilient supports.
10. Resilient pipe guides.
11. Seismic snubbers.
12. Restraining braces and cables.
13. Steel vibration isolation equipment bases.

1.3 DEFINITIONS

A. IBC: International Building Code.

B. ICC-ES: ICC-Evaluation Service.

C. OSHPD: Office of Statewide Health Planning and Development for the State of California.

1.4 PERFORMANCE REQUIREMENTS

A. Seismic-Restraint Loading:
1. Site Class as Defined in the IBC: B.
2. Assigned Seismic Use Group or Building Category as Defined in the IBC: III.
a. Component Importance Factor: 1.5.
b. Component Response Modification Factor: 2.0.
c. Component Amplification Factor: 2.5.
3. Design Spectral Response Acceleration at Short Periods (0.2 Second): 0.26 percent.
4. Design Spectral Response Acceleration at 1-Second Period: 0.10 percent.

1.5 SUBMITTALS

A. Product Data: For the following:
1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
    a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an evaluation service member of ICC-ES, OSHPD, or an agency acceptable to authorities having jurisdiction.
    b. Annotate to indicate application of each product submitted and compliance with requirements.
3. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

B. Delegated-Design Submittal: For vibration isolation and seismic-restraint details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic forces required to select vibration isolators, seismic restraints, and for designing vibration isolation bases.
2. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system has been examined for excessive stress and that none will exist.
3. Vibration Isolation Base Details: Detail overall dimensions, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment, and cantilever loads.
4. Seismic-Restraint Details:
    a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
    b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
    c. Preapproval and Evaluation Documentation: By an evaluation service member of ICC-ES, OSHPD, or an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

C. Coordination Drawings: Show coordination of seismic bracing for plumbing piping and equipment with other systems and equipment in the vicinity, including other supports and seismic restraints.

D. Welding certificates.

E. Qualification Data: For professional engineer.

1.6 QUALITY ASSURANCE

A. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

C. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproved by ICC-ES, or preapproved by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Kinetics Noise Control.
2. Mason Industries.
3. Vibration Eliminator Co., Inc.
4. Vibration Isolation.
5. Or approved equal.

B. Pads: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
1. Resilient Material: Oil- and water-resistant neoprene or rubber.

C. Mounts: Double-deflection type, with molded, oil-resistant rubber, hermetically sealed compressed fiberglass, or neoprene isolator elements with factory-drilled, encapsulated top plate for bolting to equipment and with baseplate for bolting to structure. Color-code or otherwise identify to indicate capacity range.
1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.

D. Restrained Mounts: All-directional mountings with seismic restraint.
1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.

E. Spring Isolators: Freestanding, laterally stable, open-spring isolators.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch- (6-mm-) thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig (3447 kPa).
6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

F. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.
1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch- (6-mm-) thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
2. Restraint: Seismic or limit-stop as required for equipment and authorities having jurisdiction.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

G. Housed Spring Mounts: Housed spring isolator with integral seismic snubbers.
1. Housing: Ductile-iron or steel housing to provide all-directional seismic restraint.
2. Base: Factory drilled for bolting to structure.
3. Snubbers: Vertically adjustable to allow a maximum of 1/4-inch (6-mm) travel up or down before contacting a resilient collar.

H. Elastomeric Hangers: Single or double-deflection type, fitted with molded, oil-resistant elastomeric isolator elements bonded to steel housings with threaded connections for hanger rods. Color-code or otherwise identify to indicate capacity range.

I. Spring Hangers: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.
1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

6. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
7. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

J. Spring Hangers with Vertical-Limit Stop: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression and with a vertical-limit stop.
1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
7. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
8. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

K. Pipe Riser Resilient Support: All-directional, acoustical pipe anchor consisting of 2 steel tubes separated by a minimum of 1/2-inch- (13-mm-) thick neoprene. Include steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions. Design support for a maximum load on the isolation material of 500 psig (3.45 MPa) and for equal resistance in all directions.

L. Resilient Pipe Guides: Telescopic arrangement of 2 steel tubes or post and sleeve arrangement separated by a minimum of 1/2-inch- (13-mm-) thick neoprene. Where clearances are not readily visible, a factory-set guide height with a shear pin to allow vertical motion due to pipe expansion and contraction shall be fitted. Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2.2 VIBRATION ISOLATION EQUIPMENT BASES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Kinetics Noise Control.
2. Mason Industries.
3. Vibration Eliminator Co., Inc.
4. Vibration Isolation.
5. Or approved equal.

B. Steel Base: Factory-fabricated, welded, structural-steel bases and rails.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1. Design Requirements: Lowest possible mounting height with not less than 1-inch (25-mm) clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
   a. Include supports for suction and discharge elbows for pumps.
2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

C. Inertia Base: Factory-fabricated, welded, structural-steel bases and rails ready for placement of cast-in-place concrete.
1. Design Requirements: Lowest possible mounting height with not less than 1-inch (25-mm) clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
   a. Include supports for suction and discharge elbows for pumps.
2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/ A 36M. Bases shall have shape to accommodate supported equipment.
3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
4. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

2.3 SEISMIC-RESTRAINT DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Cooper B-Line, Inc.; a division of Cooper Industries.
2. Hilti, Inc.
3. Kinetics Noise Control.
4. Mason Industries.
5. TOLCO Incorporated; a brand of NIBCO INC.
6. Unistrut; Tyco International, Ltd.
7. Or approved equal.

B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an evaluation service member of ICC-ES, OSHPD, or an agency acceptable to authorities having jurisdiction.
1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.

C. Snubbers: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.
1. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
2. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3. Maximum 1/4-inch (6-mm) air gap, and minimum 1/4-inch- (6-mm-) thick resilient cushion.

D. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.

E. Restraint Cables: ASTM A 492 stainless-steel cables with end connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.

F. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections or reinforcing steel angle clamped to hanger rod.

G. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.

H. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.

I. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

J. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.

K. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.4 FACTORY FINISHES

A. Finish: Manufacturer's standard prime-coat finish ready for field painting.

B. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.
1. Powder coating on springs and housings.
2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.
3. Baked enamel or powder coat for metal components on isolators for interior use.
4. Color-code or otherwise mark vibration isolation and seismic-control devices to indicate capacity range.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and seismic-control devices for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an evaluation service member of ICC-ES, OSHPD, or an agency acceptable to authorities having jurisdiction.

B. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.

C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.3 VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Equipment Restraints:
1. Install seismic snubbers on plumbing equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inches (3.2 mm).
3. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES, OSHPD, or an agency acceptable to authorities having jurisdiction providing required submittals for component.

B. Piping Restraints:
1. Comply with requirements in MSS SP-127.
2. Space lateral supports a maximum of 40 feet (12 m) o.c., and longitudinal supports a maximum of 80 feet (24 m) o.c. and in conjunction with individual piping sections.
3. Brace a change of direction longer than 12 feet (3.7 m).

C. Install cables so they do not bend across edges of adjacent equipment or building structure.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

D. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES, OSHPD, or an agency acceptable to authorities having jurisdiction providing required submittals for component.

E. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

F. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

G. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

H. Drilled-in Anchors:
1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless steel anchors for exterior applications.

3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Division 22 Section "Domestic Water Piping" for piping flexible connections.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Tests and Inspections:

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
5. Test to 90 percent of rated proof load of device.
6. Measure isolator restraint clearance.
7. Measure isolator deflection.
8. Verify snubber minimum clearances.
9. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.

C. Remove and replace malfunctioning units and retest as specified above.

D. Testing agency shall prepare test and inspection reports.

3.6 ADJUSTING

A. Adjust isolators after piping system is at operating weight.

B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

C. Adjust active height of sprint isolators.

D. Adjust restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

B. Should conflicts arise in this Section any Owner requirements and/or identification Specifications take precedent.

1.2 SUMMARY

A. Section Includes:
1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Stencils.
5. Valve tags.
6. Warning tags.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

C. Valve numbering scheme.

D. Valve Schedules: For each piping system to include in maintenance manuals.

1.4 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Plastic Labels for Equipment:

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch (3.2 mm) thick, and having predrilled holes for attachment hardware.
2. Letter Color: White.
3. Background Color: Black.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
6. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Fasteners: Stainless-steel self-tapping screws.

B. Label Content: Include equipment's Drawing designation or unique equipment number.

C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch (A4) bond paper. Tabulate equipment identification numbers. Provide equipment schedule with manufacturer's names, model numbers, equipment capacities, and operating requirements. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch (3.2 mm) thick, and having predrilled holes for attachment hardware.

B. Letter Color: Black.

C. Background Color: Yellow.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).

F. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless-steel self-tapping screws.

H. Label Content: Include caution and warning information, plus emergency notification instructions.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2.3 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
   1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
   2. Lettering Size: At least 1-1/2 inches (38 mm) high.

2.4 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch (6.4-mm) letters for piping system abbreviation and 1/2-inch (13-mm) numbers.
   1. Tag Material: Brass, 0.032-inch (0.8-mm) minimum thickness, and having predrilled or stamped holes for attachment hardware.
   2. Fasteners: Brass beaded chain.

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch (A4) bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
   1. Valve-tag schedule shall be included in operation and maintenance data.

2.5 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
   1. Size: Approximately 4 by 7 inches (100 by 178 mm).
   2. Fasteners: Brass grommet and wire.
   3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
   4. Color: Yellow background with black lettering.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3.2 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

A. Piping Color-Coding: Painting of piping is specified in Division 09.

B. Locate pipe labels where piping is exposed or above ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 50 feet (15 m) along each run. Reduce intervals to 25 feet (7.6 m) in areas of congested piping and equipment.
7. On piping above ceilings a minimum of once per room.

C. Pipe Label Color Schedule:
1. Compressed-Air Piping:
   a. Background Color: White.
   b. Letter Color: Black.
2. Domestic Water Piping:
   a. Background Color: Blue.
   b. Letter Color: White.
3. Sanitary Waste and Storm Drainage Piping:
   a. Background Color: Black.
   b. Letter Color: White.

3.4 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
1. Valve-Tags shall be 1-1/2 inches (38 mm) diameter round tags.
2. Valve-Tags shall be natural color brass with engraved black lettering.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3.5 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Insulation Materials:
      a. Cellular glass.
      b. Flexible elastomeric.
      c. Mineral fiber.
   2. Insulating cements.
   3. Adhesives.
   4. Mastics.
   5. Lagging adhesives.
   6. Sealants.
   7. Factory-applied jackets.
   8. Field-applied jackets.
   9. Tapes.
   10. Securements.
   11. Corner angles.

B. Related Sections include the following:
   1. Division 23 Section "HVAC Insulation."

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).

1.4 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.5 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application and equipment Installer for equipment insulation application. Establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

C. Coordinate installation and testing of heat tracing.

1.6 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Aeroflex USA Inc.; Aerocel.
      b. Armacell LLC; AP Armaflex.
      c. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.
      d. Or approved equal.

F. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type I. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. CertainTeed Corp.; Duct Wrap.
      b. Johns Manville; Microlite.
      c. Knauf Insulation; Duct Wrap.
      d. Owens Corning; All-Service Duct Wrap.
      e. Or approved equal.

G. High-Temperature, Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type V, without factory-applied jacket.
   1. Products: Subject to compliance with requirements, provide one of the following:

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

a. Johns Manville; HTB 23 Spin-Glas.
b. Owens Corning; High Temperature Flexible Batt Insulations.
c. Or approved equal.

H. Mineral-Fiber, Preformed Pipe Insulation:
1. Products: Subject to compliance with requirements, provide one of the following:
a. Johns Manville; Micro-Lok.
b. Knauf Insulation; 1000(Pipe Insulation.
c. Manson Insulation Inc.; Alley-K.
d. Owens Corning; Fiberglas Pipe Insulation.
e. Or approved equal.
2. Type I, 850 deg F (454 deg C) Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

I. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. (40 kg/cu. m) or more. Thermal conductivity (k-value) at 100 deg F (55 deg C) is 0.29 Btu x in./h x sq. ft. x deg F (0.042 W/m x K) or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
1. Products: Subject to compliance with requirements, provide one of the following:
a. Johns Manville; MicroFlex.
b. Knauf Insulation; Pipe and Tank Insulation.
c. Owens Corning; Fiberglas Pipe and Tank Insulation.
d. Or approved equal.

2.2 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.
1. Products: Subject to compliance with requirements, provide one of the following:
a. Insulco, Division of MFS, Inc.; Triple I.
b. P. K. Insulation Mfg. Co., Inc.; Super-Stik.
c. Or approved equal.

B. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.
1. Products: Subject to compliance with requirements, provide one of the following:
a. Insulco, Division of MFS, Inc.; SmoothKote.
b. P. K. Insulation Mfg. Co., Inc.; PK No. 127, and Quik-Cote.
c. Or approved equal.

2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Aeroflex USA Inc.; Aeroseal.
      b. Armacell LCC; 520 Adhesive.
      c. Foster Products Corporation, H. B. Fuller Company; 85-75.
      d. RBX Corporation; Rubatex Contact Adhesive.
      e. Or approved equal.

C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Products, Division of ITW; CP-82.
      b. Foster Products Corporation, H. B. Fuller Company; 85-20.
      c. Or approved equal.

D. ASJ Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Products, Division of ITW; CP-82.
      b. Foster Products Corporation, H. B. Fuller Company; 85-20.
      c. Or approved equal.

E. PVC Jacket Adhesive: Compatible with PVC jacket.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Dow Chemical Company (The); 739, Dow Silicone.
      b. Johns-Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
      c. Or approved equal.

2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.

B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Products, Division of ITW; CP-35.
      b. Foster Products Corporation, H. B. Fuller Company; 30-90.
      c. Or approved equal.
   2. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm (0.009 metric perm) at 43-mil (1.09-mm) dry film thickness.
   3. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).
   4. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
   5. Color: White.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2.5 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Products, Division of ITW; CP-52.
      b. Foster Products Corporation, H. B. Fuller Company; 81-42.
      c. Or approved equal.
   2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over equipment and pipe insulation.
   3. Service Temperature Range: Minus 50 to plus 180 deg F (Minus 46 to plus 82 deg C).
   4. Color: White.

2.6 SEALANTS

A. Joint Sealants:
   1. Joint Sealants for Cellular-Glass Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Products, Division of ITW; CP-76.
      b. Foster Products Corporation, H. B. Fuller Company; 30-45.
      c. Pittsburgh Corning Corporation; Pittseal 444.
      d. Or approved equal.

B. Metal Jacket Flashing Sealants:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Products, Division of ITW; CP-76-8.
      b. Foster Products Corporation, H. B. Fuller Company; 95-44.
      c. Or approved equal.
   2. Materials shall be compatible with insulation materials, jackets, and substrates.
   3. Fire- and water-resistant, flexible, elastomeric sealant.
   4. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
   5. Color: Aluminum.

C. ASJ Flashing Sealants, and Vinyl, and PVC Jacket Flashing Sealants:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Products, Division of ITW; CP-76.
      b. Or approved equal.
   2. Materials shall be compatible with insulation materials, jackets, and substrates.
   3. Fire- and water-resistant, flexible, elastomeric sealant.
   4. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
   5. Color: White.

2.7 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
   1. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2.8 FIELD-APPLIED CLOTHS

A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd. (271 g/sq. m).
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Alpha Associates, Inc.; Alpha-Maritex 84215 and 84217/9485RW, Luben 59.
      b. Or approved equal.

2.9 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Johns Manville; Zeston.
      b. P.I.C. Plastics, Inc.; FG Series.
      c. Proto PVC Corporation; LoSmoke.
      d. Speedline Corporation; SmokeSafe.
      e. Or approved equal.
   2. Adhesive: As recommended by jacket material manufacturer.
   3. Color: White. Coordinate with Interior and Exterior Painting Sections and Owner requirements.
   4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
      a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, and mechanical joints.
   5. Factory-fabricated tank heads and tank side panels.

C. Metal Jacket:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Products, Division of ITW; Metal Jacketing Systems.
      b. PABCO Metals Corporation; Surefit.
      c. RPR Products, Inc.; Insul-Mate.
      d. Or approved equal.
   2. Aluminum Jacket: Comply with ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105 or 5005, Temper H-14.
      a. Factory cut and rolled to size.
      b. Finish and thickness are indicated in field-applied jacket schedules.
      c. Moisture Barrier for Indoor Applications: 1-mil- (0.025-mm-) thick, heat-bonded polyethylene and kraft paper.
      d. Moisture Barrier for Outdoor Applications: 3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper.
      e. Factory-Fabricated Fitting Covers:
         1) Same material, finish, and thickness as jacket.
         2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
         3) Tee covers.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

4) Flange and union covers.
5) End caps.
6) Beveled collars.
7) Valve covers.
8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

D. Underground Direct-Buried Jacket: 125-mil- (3.2-mm-) thick vapor barrier and waterproofing membrane consisting of a rubberized bituminous resin reinforced with a woven-glass fiber or polyester scrim and laminated aluminum foil.
1. Products: Subject to compliance with requirements, provide one of the following:
a. Pittsburgh Corning Corporation; Pittwrap.
b. Polyguard; Insulrap No Torch 125.
c. Or approved equal.

2.10 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
1. Products: Subject to compliance with requirements, provide one of the following:
a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0835.
b. Compac Corp.; 104 and 105.
c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.
d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
e. Or approved equal.
2. Width: 3 inches (75 mm).
3. Thickness: 11.5 mils (0.29 mm).
4. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.
1. Products: Subject to compliance with requirements, provide one of the following:
a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0555.
b. Compac Corp.; 130.
c. Ideal Tape Co., Inc., an American Biltrite Company; 370 White PVC tape.
d. Venture Tape; 1506 CW NS.
e. Or approved equal.
2. Width: 2 inches (50 mm).
3. Thickness: 6 mils (0.15 mm).
4. Adhesion: 64 ounces force/inch (0.7 N/mm) in width.
5. Elongation: 500 percent.
6. Tensile Strength: 18 lbf/inch (3.3 N/mm) in width.

C. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Products: Subject to compliance with requirements, provide one of the following:

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
b. Compac Corp.; 120.
c. Ideal Tape Co., Inc., an American Biltrite Company; 488 AWF.
d. Venture Tape; 3520 CW.
e. Or approved equal.

2. Width: 2 inches (50 mm).
3. Thickness: 3.7 mils (0.093 mm).
4. Adhesion: 100 ounces force/inch (1.1 N/mm) in width.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch (6.2 N/mm) in width.

2.11 SECUREMENTS

A. Bands:
1. Products: Subject to compliance with requirements, provide one of the following:
a. Childers Products; Bands.
b. PABCO Metals Corporation; Bands.
c. RPR Products, Inc.; Bands.
d. Or approved equal.
2. Aluminum: ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch (0.51 mm) thick, 1/2 inch (13 mm) wide with wing seal.

B. Insulation Pins and Hangers:
1. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
a. Products: Subject to compliance with requirements, provide one of the following:
1) GEMCO; Nylon Hangers.
2) Midwest Fasteners, Inc.; Nylon Insulation Hangers.
3) Or approved equal.
b. Baseplate: Perforated, nylon sheet, 0.030 inch (0.76 mm) thick by 1-1/2 inches (38 mm) in diameter.
c. Spindle: Nylon, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches (63 mm).
d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
2. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.
a. Products: Subject to compliance with requirements, provide one of the following:
1) GEMCO.
2) Midwest Fasteners, Inc.
3) Or approved equal.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- (19-mm-) wide, stainless steel or Monel.

D. Wire: 0.062-inch (1.6-mm) soft-annealed, stainless steel.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. C & F Wire.
   b. Childers Products.
   c. PABCO Metals Corporation.
   d. RPR Products, Inc.
   e. Or approved equal.

2.12 CORNER ANGLES

A. PVC Corner Angles: 30 mils (0.8 mm) thick, minimum 1 by 1 inch (25 by 25 mm), PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.

B. Aluminum Corner Angles: 0.040 inch (1.0 mm) thick, minimum 1 by 1 inch (25 by 25 mm), aluminum according to ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105 or 5005; Temper H-14.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
1. Verify that systems and equipment to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment and piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment and pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
   1. Install insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
   3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
   4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:
   1. Draw jacket tight and smooth.
   2. Cover circumferential joints with 3-inch- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches (100 mm) o.c.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches (100 mm) o.c.
   a. For below ambient services, apply vapor-barrier mastic over staples.
4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above ambient services, do not install insulation to the following:
1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches (50 mm) below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
1. Seal penetrations with flashing sealant.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches (50 mm).
4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
1. Comply with requirements in Division 07 for firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:
1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07.

3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.

6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations required. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches (50 mm) over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3.6 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Fittings and Elbows:
   1. Install mitered sections of pipe insulation.
   2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.7 MINERAL-FIBER INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:
   1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
   2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
   3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches (150 mm) o.c.
   4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:
   1. Install preformed pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
   4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch (25 mm), and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:
   1. Install preformed sections of same material as straight segments of pipe insulation when available.
   2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:
   1. Install preformed sections of same material as straight segments of pipe insulation when available.
   2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
   3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   4. Install insulation to flanges as specified for flange insulation application.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3.8 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
   1. Draw jacket smooth and tight to surface with 2-inch (50-mm) overlap at seams and joints.
   2. Embed glass cloth between two 0.062-inch- (1.6-mm-) thick coats of lagging adhesive.
   3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where PVC jackets are indicated, install with 1-inch (25-mm) overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.
   1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

C. Where metal jackets are indicated, install with 2-inch (50-mm) overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches (300 mm) o.c. and at end joints.

3.9 FINISHES

A. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

3.10 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
   1. Drainage piping located in crawl spaces.
   2. Underground piping.
   3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.11 INDOOR PIPING INSULATION SCHEDULE

A. Domestic Cold Water:
   1. NPS 1 (DN 25) and Smaller: Insulation shall be the following:
      a. Flexible Elastomeric (Below Slab-on-Grade Only): 1/2 inch (13 mm) thick.
      b. Mineral-Fiber, Preformed Pipe Insulation, Type I (Above Grade): 1/2 inch (13 mm) thick.
   2. NPS 1-1/4 (DN 32) and Larger: Insulation shall be the following:
      a. Flexible Elastomeric (Below Slab-on-Grade Only): 1 inch (25 mm) thick.
      b. Mineral-Fiber, Preformed Pipe Insulation, Type I (Above Grade): 1 inch (25 mm) thick.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Domestic Hot and Recirculated Hot Water:
   1. NPS 1-1/4 (DN 32) and Smaller: Insulation shall be the following:
      a. Flexible Elastomeric (Below Slab-on-Grade Only): 1 inch (25 mm) thick.
      b. Mineral-Fiber, Preformed Pipe Insulation, Type I (Above Grade): 1/2 inch (13 mm) thick.
   2. NPS 1-1/2 (DN 40) and Larger: Insulation shall be the following:
      a. Flexible Elastomeric (Below Slab-on-Grade Only): 1 inch (25 mm) thick.
      b. Mineral-Fiber, Preformed Pipe Insulation, Type I (Above Grade): 1 inch (25 mm) thick.

C. Domestic Chilled Water (Potable):
   1. All Pipe Sizes: Insulation shall be the following:
      a. Flexible Elastomeric (Below Slab-on-Grade Only): 1 inch (25 mm) thick.
      b. Mineral-Fiber, Preformed Pipe Insulation, Type I (Above Grade): 1 inch (25 mm) thick.

D. Stormwater and Overflow:
   1. All Pipe Sizes: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.

E. Roof Drain and Overflow Drain Bodies:
   1. All Pipe Sizes: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.

F. Sanitary Waste Piping Where Heat Tracing Is Installed:
   1. All Pipe Sizes: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1-1/2 inches (38 mm) thick.

G. Condensate and Equipment Drain Water below 60 Deg F (16 Deg C):
   1. All Pipe Sizes: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch (13 mm) thick.

H. Above Grade Floor Drains, Traps, and Sanitary Drain Piping within 10 feet (3 m) of Drain Receiving Condensate and Equipment Drain Water below 60 Deg F (16 Deg C):
   1. All Pipe Sizes: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch (13 mm) thick.

I. Hot Service Drains:
   1. All Pipe Sizes: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe, Type I or II: 1 inch (25 mm) thick.

3.12 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Domestic Water Piping:
   1. All Pipe Sizes: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches (50 mm) thick.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Domestic Hot and Recirculated Hot Water:
   1. All Pipe Sizes: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches (50 mm) thick.

C. Sanitary Waste Piping Where Heat Tracing Is Installed:
   1. All Pipe Sizes: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches (50 mm) thick.

3.13 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Equipment, Concealed:
   1. PVC.

D. Equipment, Exposed, up to 48 Inches (1200 mm) in Diameter or with Flat Surfaces up to 72 Inches (1800 mm):
   1. None.
   2. Installed 7'-0" or More Above Finished Floor: PVC, 20 mils (0.5 mm) thick.
   3. Installed Less than 7'-0" Above Finished Floor: Aluminum, corrugated, 0.024 inch (0.61 mm) thick.

E. Equipment, Exposed, Larger Than 48 Inches (1200 mm) in Diameter or with Flat Surfaces Larger Than 72 Inches (1800 mm):
   1. Aluminum with 1-1/4-Inch- (32-mm-) Deep Corrugations: 0.040 inch (1.0 mm) thick.

F. Piping, Exposed:
   1. 7'-0" or More Above Finished Floor: None.
   2. Less than 7'-0" Above Finished Floor: Aluminum, corrugated, 0.024 inch (0.61 mm) thick.

3.14 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. Piping, Concealed:
   1. None.

C. Piping, Exposed:
   1. Stainless Steel, Type 316, corrugated with Z-Shaped Locking Seam: 0.020 inch (0.51 mm) thick.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
1. Under-building slab and aboveground domestic water pipes, tubes, fittings, and specialties inside the building.
2. Encasement for piping.
3. Specialty valves.
4. Flexible connectors.
5. Escutcheons.
6. Sleeves and sleeve seals.
7. Wall penetration systems.

1.3 SUBMITTALS

A. Product Data: For the following products:
1. Specialty valves.
2. Transition fittings.
3. Dielectric fittings.
4. Flexible connectors.
5. Backflow preventers and vacuum breakers.
6. Escutcheons.
7. Sleeves and sleeve seals.
8. Water penetration systems.

1.4 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 14 for plastic, potable domestic water piping and components. Include marking "NSF-pw" on piping.

C. Comply with NSF 61 for potable domestic water piping and components.

1.5 PROJECT CONDITIONS

A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:
1. Notify Owner no fewer than two days in advance of proposed interruption of water service.
2. Do not proceed with interruption of water service without Owner’s written permission.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.2 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B 88, Type L (ASTM B 88M, Type B) water tube, drawn temper.
   1. Cast-Copper Solder-Joint Fittings: ASME B16.18, pressure fittings.
   2. Wrought-Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
   3. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
   4. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
   5. Copper Pressure-Seal-Joint Fittings:
      a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         1) Elkhart Products Corporation; Industrial Division.
         2) NIBCO INC.
         3) Viega; Plumbing and Heating Systems.
         4) Or approved equal.
      b. NPS 2 (DN 50) and Smaller: Wrought-copper fitting with EPDM-rubber O-ring seal in each end.
      c. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Cast-bronze or wrought-copper fitting with EPDM-rubber O-ring seal in each end.
   6. Copper Push-on-Joint Fittings:
      a. Manufacturers: Subject to compliance with requirements, provide products by the following:
         1) NVent LLC.
         2) Or approved equal.
      b. Description: Cast-copper fitting complying with ASME B16.18 or wrought-copper fitting complying with ASME B 16.22; with stainless-steel teeth and EPDM-rubber O-ring seal in each end instead of solder-joint ends.
   7. Grooved-Joint Copper-Tube Appurtenances:
      a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         1) Anvil International.
         2) Shurjoint Piping Products.
         3) Victaulic Company.
         4) Or approved equal.
      b. Copper Grooved-End Fittings: ASTM B 75 (ASTM B 75M) copper tube or ASTM B 584 bronze castings.
      c. Grooved-End-Tube Couplings: Copper-tube dimensions and design similar to AWWA C606. Include ferrous housing sections, EPDM-rubber gaskets suitable for hot and cold water, and bolts and nuts.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Soft Copper Tube: ASTM B 88, Type K (ASTM B 88M, Type A) and ASTM B 88, Type L (ASTM B 88M, Type B) water tube, annealed temper.
   1. Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
   2. Copper Pressure-Seal-Joint Fittings:
      a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         1) Elkhart Products Corporation; Industrial Division.
         2) NIBCO INC.
         3) Viega; Plumbing and Heating Systems.
         4) Or approved equal.
      b. NPS 2 (DN 50) and Smaller: Wrought-copper fitting with EPDM-rubber O-ring seal in each end.
      c. NPS 3 and NPS 4 (DN 80 and DN 100): Cast-bronze or wrought-copper fitting with EPDM-rubber O-ring seal in each end.

2.3 DUCTILE-IRON PIPE AND FITTINGS

A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
   1. Standard-Pattern, Mechanical-Joint Fittings: AWWA C110, ductile or gray iron.
   2. Compact-Pattern, Mechanical-Joint Fittings: AWWA C153, ductile iron.
      a. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

B. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.
   1. Standard-Pattern, Push-on-Joint Fittings: AWWA C110, ductile or gray iron.
      a. Gaskets: AWWA C111, rubber.
   2. Compact-Pattern, Push-on-Joint Fittings: AWWA C153, ductile iron.
      a. Gaskets: AWWA C111, rubber.

C. Plain-End, Ductile-Iron Pipe: AWWA C151.
   1. Grooved-Joint, Ductile-Iron-Pipe Appurtenances:
      a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         1) Anvil International.
         2) Shurjoint Piping Products.
         3) Star Pipe Products.
         4) Victaulic Company.
         5) Or approved equal.
      b. Grooved-End, Ductile-Iron Fittings: ASTM A 47/A 47M, malleable-iron castings or ASTM A 536, ductile-iron castings with dimensions matching pipe.
      c. Grooved-End, Ductile-Iron-Pipe Couplings: AWWA C606 for ductile-iron-pipe dimensions. Include ferrous housing sections, EPDM-rubber gaskets suitable for hot and cold water, and bolts and nuts.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2.4 GALVANIZED-STEEL PIPE AND FITTINGS

A. Galvanized-Steel Pipe: ASTM A 53/A 53M, Type E, Grade B, Standard Weight. Include ends matching joining method.
   1. Galvanized-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106/A 106M, Standard Weight, seamless steel pipe with threaded ends.
   2. Galvanized, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.
   3. Malleable-Iron Unions: ASME B16.39, Class 150, hexagonal-stock body with ball-and-socket, metal-to-metal, bronze seating surface, and female threaded ends.
   4. Flanges: ASME B16.1, Class 125, cast iron.
   5. Grooved-Joint, Galvanized-Steel-Pipe Appurtenances:
      a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         1) Anvil International.
         2) Shurjoint Piping Products.
         3) Star Pipe Products.
         4) Victaulic Company.
         5) Or approved equal.
      b. Galvanized, Grooved-End Fittings for Galvanized-Steel Piping: ASTM A 47/A 47M, malleable-iron casting; ASTM A 106/A 106M, steel pipe; or ASTM A 536, ductile-iron casting; with dimensions matching steel pipe.
      c. Grooved-End-Pipe Couplings for Galvanized-Steel Piping: AWWA C606 for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gaskets suitable for hot and cold water, and bolts and nuts.

2.5 PVC PIPE AND FITTINGS

A. PVC Pipe: ASTM D 1785, Schedule 40 and Schedule 80.
   1. PVC Socket Fittings: ASTM D 2466 for Schedule 40 and ASTM D 2467 for Schedule 80.
   2. PVC Schedule 80 Threaded Fittings: ASTM D 2464.

2.6 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick or ASME B16.21, nonmetallic and asbestos free, unless otherwise indicated; full-face or ring type unless otherwise indicated.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

D. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

E. Solvent Cements for Joining CPVC Piping and Tubing: ASTM F 493.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

F. Solvent Cements for Joining PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

G. Plastic, Pipe-Flange Gaskets, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

2.7 ENCASEMENT FOR PIPING

A. Standard: ASTM A 674 or AWWA C105.

B. Form: Tube.

C. Material: High-density, cross-laminated PE film of 0.004-inch (0.10-mm) minimum thickness.

D. Color: Black.

2.8 SPECIALTY VALVES

A. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for balancing valves, drain valves, backflow preventers, and vacuum breakers.

B. PVC Union Ball Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Valve, Inc.
   b. Asahi/America, Inc.
   c. Colonial Engineering, Inc.
   d. Fischer, George Inc.
   e. Hayward Flow Control Systems; Hayward Industrial Products, Inc.
   f. IPEX Inc.
   g. Jomar International, LTD.
   h. King Bros. Industries.
   i. Legend Valve.
   j. McDonald, A.Y. Mfg. Co.
   k. NIBCO INC.
   l. Sloane, George Fischer, Inc.
   m. Spears Manufacturing Company.
   n. Thermoplastic Valves Inc.
   o. Or approved equal.
2. Description:
   a. Standard: MSS SP-122.
   b. Pressure Rating: 150 psig (1035 kPa) at 73 degrees F. (23 degrees C.)
   c. Body Material: PVC.
   d. Body Design: Union type.
   e. End Connections for Valves NPS 2 (DN 50) and Smaller: Detachable, socket or threaded.
   f. End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Detachable, socket or threaded.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

g. Ball: PVC; full port.
h. Seals: PTFE or EPDM-rubber O-rings.
i. Handle: Tee shaped.

C. PVC Non-Union Ball Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. American Valve, Inc.
b. Asahi/America, Inc.
c. Colonial Engineering, Inc.
d. Hayward Flow Control Systems; Hayward Industrial Products, Inc.
e. IPEX Inc.
f. Jomar International, LTD.
g. King Bros. Industries.
h. Legend Valve.
i. McDonald, A.Y. Mfg. Co.
j. NIBCO INC.
k. Sloane, George Fischer, Inc.
l. Spears Manufacturing Company.
m. Thermoplastic Valves Inc.
n. Or approved equal.
2. Description:
a. Standard: MSS SP-122.
b. Pressure Rating: 150 psig (1035 kPa) at 73 degrees F. (23 degrees C.).
c. Body Material: PVC.
d. Body Design: Non-union type.
e. End Connections: Socket or threaded.
f. Ball: PVC; full or reduced port.
g. Seals: PTFE or EPDM-rubber O-rings.
h. Handle: Tee shaped.

D. PVC Butterfly Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. American Valve, Inc.
b. Asahi/America, Inc.
c. Colonial Engineering, Inc.
d. Fischer, George Inc.
e. Hayward Flow Control Systems; Hayward Industrial Products, Inc.
f. IPEX Inc.
g. Legend Valve.
h. NIBCO INC.
i. Sloane, George Fischer, Inc.
j. Spears Manufacturing Company.
k. Thermoplastic Valves Inc.
l. Or approved equal.
2. Description:
a. Pressure Rating: 150 psig (1035 kPa) at 73 degrees F. (23 degrees C.).

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

b. Body Material: PVC.
c. Body Design: Lug or wafer type.
d. Seat: EPDM rubber.
e. Seals: PTFE or EPDM-rubber O-rings.
f. Disc: PVC.
g. Stem: Stainless steel.
h. Handle: Lever.

E. PVC Ball Check Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. American Valve, Inc.
b. Asahi/America, Inc.
c. Colonial Engineering, Inc.
d. Fischer, George Inc.
e. Hayward Flow Control Systems; Hayward Industrial Products, Inc.
f. IPEX Inc.
g. Legend Valve.
h. NIBCO INC.
i. Sloane, George Fischer, Inc.
j. Spears Manufacturing Company.
k. Thermoplastic Valves Inc.
l. Or approved equal.
2. Description:
a. Pressure Rating: 150 psig (1035 kPa) at 73 degrees F. (23 degrees C.).
b. Body Material: PVC.
c. Body Design: Union-type ball check.
d. End Connections for Valves NPS 2 (DN 50) and Smaller: Detachable, socket or threaded.
e. End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Detachable, socket or threaded.
f. Ball: PVC.
g. Seals: EPDM- or FKM-rubber O-rings.

F. PVC Gate Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Asahi/America, Inc.
b. King Bros. Industries.
c. Sloane, George Fischer, Inc.
d. Spears Manufacturing Company.
e. Or approved equal.
2. Description:
a. Pressure Rating: 150 psig (1035 kPa) at 73 degrees F. (23 degrees C.).
b. Body Material: PVC.
c. Body Design: Nonrising stem.
d. End Connections for Valves NPS 2 (DN 50) and Smaller: Socket or threaded.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

e. End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Socket or threaded.
f. Gate and Stem: Plastic.
g. Seals: EPDM rubber.
h. Handle: Wheel.

2.9 TRANSITION FITTINGS

A. General Requirements:
1. Same size as pipes to be joined.
2. Pressure rating at least equal to pipes to be joined.
3. End connections compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

C. Sleeve-Type Transition Coupling: AWWA C219.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Cascade Waterworks Manufacturing.
b. Dresser, Inc.; Dresser Piping Specialties.
c. Ford Meter Box Company, Inc. (The).
d. JCM Industries.
e. Romac Industries, Inc.
f. Smith-Blair, Inc; a Sensus company.
g. Viking Johnson; c/o Mueller Co.
h. Or approved equal.

D. Plastic-to-Metal Transition Fittings:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Charlotte Pipe and Foundry Company.
b. Harvel Plastics, Inc.
c. Spears Manufacturing Company.
d. Or approved equal.
2. Description: PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert and one solvent-cement-socket or threaded end.

E. Plastic-to-Metal Transition Unions:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Colonial Engineering, Inc.
b. NIBCO INC.
c. Spears Manufacturing Company.
d. Or approved equal.
2. Description: PVC four-part union. Include brass or stainless-steel threaded end, solvent-cement-joint or threaded plastic end, rubber O-ring, and union nut.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2.10 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials or ferrous material body with separating nonconductive insulating material suitable for system fluid, pressure, and temperature.

B. Dielectric Unions:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Capitol Manufacturing Company.
      b. Central Plastics Company.
      c. EPCO Sales, Inc.
      d. Hart Industries International, Inc.
      e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
      f. Zurn Plumbing Products Group; Wilkins Water Control Products.
      g. Or approved equal.
   2. Description:
      a. Pressure Rating: 150 psig (1035 kPa) at 180 deg F (82 deg C).
      b. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Capitol Manufacturing Company.
      b. Central Plastics Company.
      c. EPCO Sales, Inc.
      d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
      e. Or approved equal.
   2. Description:
      a. Factory-fabricated, bolted, companion-flange assembly.
      b. Pressure Rating: 150 psig (1035 kPa).
      c. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Kits:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Advance Products & Systems, Inc.
      b. Calpico, Inc.
      c. Central Plastics Company.
      d. Pipeline Seal and Insulator, Inc.
      e. Or approved equal.
   2. Description:
      a. Nonconducting materials for field assembly of companion flanges.
      b. Pressure Rating: 150 psig (1035 kPa).
      c. Gasket: Neoprene or phenolic.
      d. Bolt Sleeves: Phenolic or polyethylene.
      e. Washers: Phenolic with steel backing washers.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

E. Dielectric Couplings:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Calpico, Inc.
      b. Lochinvar Corporation.
      c. Or approved equal.
   2. Description:
      a. Galvanized-steel coupling.
      b. Pressure Rating: 300 psig (2070 kPa) at 225 deg F (107 deg C).
      c. End Connections: Female threaded.
      d. Lining: Inert and noncorrosive, thermoplastic.

F. Dielectric Nipples:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Perfection Corporation; a subsidiary of American Meter Company.
      b. Precision Plumbing Products, Inc.
      c. Victaulic Company.
      d. Or approved equal.
   2. Description:
      a. Electroplated steel nipple complying with ASTM F 1545.
      b. Pressure Rating: 300 psig (2070 kPa) at 225 deg F (107 deg C).
      c. End Connections: Male threaded or grooved.
      d. Lining: Inert and noncorrosive, propylene.

2.11 FLEXIBLE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Flex-Hose Co., Inc.
   2. Flexicraft Industries.
   3. Flex Pression, Ltd.
   4. Flex-Weld, Inc.
   5. Hyspan Precision Products, Inc.
   6. Mercer Rubber Co.
   7. Metraflex, Inc.
   8. Proco Products, Inc.
   9. Tozen Corporation.
   10. Unaflex, Inc.
   11. Universal Metal Hose; a Hyspan company.
   12. Or approved equal.

B. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
   1. Working-Pressure Rating: Minimum 200 psig (1380 kPa).
   2. End Connections NPS 2 (DN 50) and Smaller: Threaded copper pipe or plain-end copper tube.
   3. End Connections NPS 2-1/2 (DN 65) and Larger: Flanged copper alloy.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

C. Stainless-Steel-Hose Flexible Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.
   1. Working-Pressure Rating: Minimum 200 psig (1380 kPa).
   2. End Connections NPS 2 (DN 50) and Smaller: Threaded steel-pipe nipple.
   3. End Connections NPS 2-1/2 (DN 65) and Larger: Flanged steel nipple.

2.12 ESCUTCHEONS

A. General: Manufactured ceiling, floor, and wall escutcheons and floor plates.

B. One Piece, Cast Brass: Polished, chrome-plated finish with setscrews.

C. One Piece, Stamped Steel: Chrome-plated finish with setscrew.

D. Split Plate, Stamped Steel: Chrome-plated finish with concealed or exposed-rivet hinge or setscrew.

E. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.

F. Split-Casting Floor Plates: Cast brass with concealed hinge.

2.13 SLEEVES

A. Cast-Iron Wall Pipes: Fabricated of cast iron, and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Molded-PE Sleeves: Reusable, PE, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc-coated, with plain ends.

D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
   1. Underdeck Clamp: Clamping ring with setscrews.

2.14 SLEEVE SEALS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Advance Products & Systems, Inc.
   2. Calpico, Inc.
   3. Metraflex, Inc.
   4. Pipeline Seal and Insulator, Inc.
   5. Or approved equal.

B. Description: Modular sealing element unit, designed for field assembly, used to fill annular space between pipe and sleeve.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Carbon steel.
3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.15 WALL PENETRATION SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. SIGMA.
2. Or approved equal.

B. Description: Wall-sleeve assembly, consisting of housing and gland, gaskets, and pipe sleeve.
1. Carrier-Pipe Deflection: Up to 5 percent without leakage.
2. Housing: Ductile-iron casting with hub, waterstop, anchor ring, and locking devices. Include gland, bolts, and nuts.
3. Housing-to-Sleeve Gasket: EPDM rubber.
4. Housing-to-Carrier-Pipe Gasket: AWWA C111, EPDM rubber.
5. Pipe Sleeve: AWWA C151, ductile-iron pipe.

2.16 GROUT

A. Standard: ASTM C 1107, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Comply with requirements in Division 31 Section "Site Excavation, Backfilling, and Compaction" for excavating, trenching, and backfilling.

3.2 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

C. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.

D. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve, inside the building at each domestic water service entrance. Comply with requirements in Division 22 for pressure gages, drain valves, and strainers.

E. Install shutoff valve immediately upstream of each dielectric fitting.

F. Install domestic water piping level with 0.25 percent slope downward toward drain.

G. Install seismic restraints on piping. Comply with requirements in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment" for seismic-restraint devices.

H. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

I. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

J. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

K. Install piping adjacent to equipment and specialties to allow service and maintenance.

L. Install piping to permit valve servicing.

M. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than system pressure rating used in applications below unless otherwise indicated.

N. Install piping free of sags and bends.

O. Install fittings for changes in direction and branch connections.

P. Install PEX piping with loop at each change of direction of more than 90 degrees.

Q. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

R. Install pressure gages on suction and discharge piping from each plumbing pump and packaged booster pump. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages.

S. Install thermometers on inlet and outlet piping from each water heater.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3.3 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

D. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter.

E. Soldered Joints: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

F. Pressure-Sealed Joints: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer.

G. Copper-Tubing, Push-on Joints: Clean end of tube. Measure insertion depth with manufacturer's depth gage. Join copper tube and push-on-joint fittings by inserting tube to measured depth.

H. Extruded-Tee Connections: Form tee in copper tube according to ASTM F 2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.

I. Copper-Tubing Grooved Joints: Roll groove end of tube. Assemble coupling with housing, gasket, lubricant, and bolts. Join copper tube and grooved-end fittings according to AWWA C606 for roll-grooved joints.

J. Ductile-Iron-Piping Grooved Joints: Cut groove end of pipe. Assemble coupling with housing, gasket, lubricant, and bolts. Join ductile-iron pipe and grooved-end fittings according to AWWA C606 for ductile-iron-pipe, cut-grooved joints.

K. Steel-Piping Grooved Joints: Roll groove end of pipe. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.

L. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.

M. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements. Apply primer.
2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
3. PVC Piping: Join according to ASTM D 2855.

N. PEX Piping Joints: Join according to ASTM F 1807.

O. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.4 VALVE INSTALLATION

A. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops. Use ball or gate valves for piping NPS 2 (DN 50) and smaller. Use butterfly or gate valves for piping NPS 2-1/2 (DN 65) and larger.

B. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping.
1. Hose-End Drain Valves: At low points in water mains, risers, and branches.
2. Stop-and-Waste Drain Valves: Instead of hose-end drain valves where indicated.

3.5 TRANSITION FITTING INSTALLATION

A. Install transition couplings at joints of dissimilar piping.

B. Transition Fittings in Underground Domestic Water Piping:
1. NPS 1-1/2 (DN 40) and Smaller: Fitting-type coupling.
2. NPS 2 (DN 50) and Larger: Sleeve-type coupling.

C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 (DN 50) and Smaller: Plastic-to-metal transition fittings or unions.

3.6 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 (DN 50) and Smaller: Use dielectric couplings or nipples.

C. Dielectric Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Use dielectric flanges.

D. Dielectric Fittings for NPS 5 (DN 125) and Larger: Use dielectric flange kits.

3.7 FLEXIBLE CONNECTOR INSTALLATION

A. Install bronze-hose flexible connectors in copper domestic water tubing.

B. Install stainless-steel-hose flexible connectors in steel domestic water piping.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3.8 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment" for seismic-restraint devices.

B. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support products and installation.
   1. Vertical Piping: MSS Type 8 or 42, clamps.
   2. Individual, Straight, Horizontal Piping Runs:
      a. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
      b. Longer Than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.
      c. Longer Than 100 Feet (30 m) If Indicated: MSS Type 49, spring cushion rolls.
   3. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
   4. Base of Vertical Piping: MSS Type 52, spring hangers.

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch (10 mm).

E. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 3/4 (DN 20) and Smaller: 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
   2. NPS 1 and NPS 1-1/4 (DN 25 and DN 32): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
   3. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
   4. NPS 2-1/2 (DN 65): 108 inches (2700 mm) with 1/2-inch (13-mm) rod.
   5. NPS 3 to NPS 5 (DN 80 to DN 125): 10 feet (3 m) with 1/2-inch (13-mm) rod.
   6. NPS 6 (DN 150): 10 feet (3 m) with 5/8-inch (16-mm) rod.
   7. NPS 8 (DN 200): 10 feet (3 m) with 3/4-inch (19-mm) rod.

F. Install supports for vertical copper tubing every 10 feet (3 m).

G. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/4 (DN 32) and Smaller: 84 inches (2100 mm) with 3/8-inch (10-mm) rod.
   2. NPS 1-1/2 (DN 40): 108 inches (2700 mm) with 3/8-inch (10-mm) rod.
   3. NPS 2 (DN 50): 10 feet (3 m) with 3/8-inch (10-mm) rod.
   4. NPS 2-1/2 (DN 65): 11 feet (3.4 m) with 1/2-inch (13-mm) rod.
   5. NPS 3 and NPS 3-1/2 (DN 80 and DN 90): 12 feet (3.7 m) with 1/2-inch (13-mm) rod.
   6. NPS 4 and NPS 5 (DN 100 and DN 125): 12 feet (3.7 m) with 5/8-inch (16-mm) rod.
   7. NPS 6 (DN 150): 12 feet (3.7 m) with 3/4-inch (19-mm) rod.
   8. NPS 8 to NPS 12 (DN 200 to DN 300): 12 feet (3.7 m) with 7/8-inch (22-mm) rod.

H. Install supports for vertical steel piping every 15 feet (4.5 m).

I. Install hangers for vertical PEX piping every 48 inches (1200 mm).

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

J. Install vinyl-coated hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 2 (DN 50) and Smaller: 48 inches (1200 mm) with 3/8-inch (10-mm) rod.
   2. NPS 2-1/2 to NPS 3-1/2 (DN 65 to DN 90): 48 inches (1200 mm) with 1/2-inch (13-mm) rod.
   3. NPS 4 and NPS 5 (DN 100 and DN 125): 48 inches (1200 mm) with 5/8-inch (16-mm) rod.
   4. NPS 6 (DN 150): 48 inches (1200 mm) with 3/4-inch (19-mm) rod.
   5. NPS 8 (DN 200): 48 inches (1200 mm) with 7/8-inch (22-mm) rod.

K. Install supports for vertical PVC piping every 48 inches (1200 mm).

L. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

3.9 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment and machines to allow service and maintenance.

C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
   1. Domestic Water Booster Pumps: Cold-water suction and discharge piping.
   2. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
   3. Plumbing Fixtures: Cold- and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code. Comply with requirements in Division 22 plumbing fixture Sections for connection sizes.
   4. Equipment: Cold- and hot-water supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 (DN 65) and larger.

3.10 ESCUTCHEON INSTALLATION

A. Install escutcheons for penetrations of walls, ceilings, and floors.

B. Escutcheons for New Piping:
   1. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
   2. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish] [stamped steel with set screw.
   3. Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
   4. Bare Piping in Unfinished Service Spaces: One piece, cast brass with polished chrome-plated finish.
   5. Bare Piping in Equipment Rooms: One piece, cast brass.
   6. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece floor plate.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

C. Escutcheons for Existing Piping:
   1. Chrome-Plated Piping: Split casting, cast brass with chrome-plated finish.
   2. Insulated Piping: Split plate, stamped steel with concealed or exposed-rivet hinge and spring clips.
   3. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split cast brass with chrome-plated finish.
   4. Bare Piping at Ceiling Penetrations in Finished Spaces: Split casting, cast brass with chrome-plated finish.
   5. Bare Piping in Unfinished Service Spaces: Split casting, cast brass with polished chrome-plated finish.
   6. Bare Piping in Equipment Rooms: Split casting, cast brass.
   7. Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting floor plate.

3.11 SLEEVE INSTALLATION

A. General Requirements: Install sleeves for pipes and tubes passing through penetrations in floors, partitions, roofs, and walls.

B. Sleeves are not required for core-drilled holes.

C. Permanent sleeves are not required for holes formed by removable PE sleeves.

D. Cut sleeves to length for mounting flush with both surfaces unless otherwise indicated.

E. Install sleeves in new partitions, slabs, and walls as they are built.

F. For interior wall penetrations, seal annular space between sleeve and pipe or pipe insulation using joint sealants appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants" for joint sealants.

G. For exterior wall penetrations above grade, seal annular space between sleeve and pipe using joint sealants appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants" for joint sealants.

H. For exterior wall penetrations below grade, seal annular space between sleeve and pipe using wall penetration systems specified in this Section.

I. Seal space outside of sleeves in concrete slabs and walls with grout.

J. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) minimum annular clear space between sleeve and pipe or pipe insulation unless otherwise indicated by local seismic requirements.

K. Install sleeve materials according to the following applications:
   1. Sleeves for Piping Passing through Concrete Floor Slabs: Steel pipe.
   2. Sleeves for Piping Passing through Concrete Floor Slabs of Mechanical Equipment Areas or Other Wet Areas: Stack sleeve fittings.
      a. Extend sleeves 2 inches (50 mm) above finished floor level.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

b. For pipes penetrating floors with membrane waterproofing, extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level. Comply with requirements in Division 07 for flashing.

3. Sleeves for Piping Passing through Gypsum-Board Partitions:
   a. PVC pipe sleeves for pipes smaller than NPS 6 (DN 150).
   b. Galvanized-steel sheet sleeves for pipes NPS 6 (DN 150) and larger.
   c. Exception: Sleeves are not required for water supply tubes and waste pipes for individual plumbing fixtures if escutcheons will cover openings.
4. Sleeves for Piping Passing through Concrete Roof Slabs: Steel pipe.
5. Sleeves for Piping Passing through Exterior Concrete Walls:
   a. Steel pipe sleeves for pipes smaller than NPS 6 (DN 150).
   b. Cast-iron wall pipe sleeves for pipes NPS 6 (DN 150) and larger.
   c. Install sleeves that are large enough to provide 1-inch (25-mm) annular clear space between sleeve and pipe or pipe insulation when sleeve seals are used.
   d. Do not use sleeves when wall penetration systems are used or as required by local seismic codes.
6. Sleeves for Piping Passing through Interior Concrete Walls:
   a. Steel pipe sleeves for pipes smaller than NPS 6 (DN 150).
   b. Galvanized-steel sheet sleeves for pipes NPS 6 (DN 150) and larger.

L. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements in Division 07 and local codes firestop materials and installations.

3.12 SLEEVE SEAL INSTALLATION

A. Install sleeve seals in sleeves in exterior concrete walls at water-service piping entries into building.

B. Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble sleeve seal components and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.13 WALL PENETRATION SYSTEM INSTALLATION

A. Install wall penetration systems in new, exterior concrete walls.

B. Assemble wall penetration system components with sleeve pipe. Install so that end of sleeve pipe and face of housing are flush with wall. Adjust locking devices to secure sleeve pipe in housing.

3.14 IDENTIFICATION

A. Identify system components. Comply with requirements in Division 22 Section "Identification for Plumbing Piping and Equipment" for identification materials and installation.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Label pressure piping with system operating pressure.

3.15 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Piping Inspections:
   1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
   2. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
      a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
      b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
   3. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
   4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

C. Piping Tests:
   1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
   2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
   3. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
   4. Cap and subject piping to static water pressure of 50 psig (345 kPa) above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
   5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
   6. Prepare reports for tests and for corrective action required.

D. Domestic water piping will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.16 ADJUSTING

A. Perform the following adjustments before operation:
   1. Close drain valves, hydrants, and hose bibbs.
   2. Open shutoff valves to fully open position.
   3. Open throttling valves to proper setting.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
   a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide flow of hot water in each branch.
   b. Adjust calibrated balancing valves to flows indicated.
5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.17 CLEANING

A. Clean and disinfect potable and non-potable domestic water piping as follows:
   1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
   2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
      a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
      b. Fill and isolate system according to either of the following:
         1) Fill system or part thereof with water/chlorine solution with at least 50 ppm (50 mg/L) of chlorine. Isolate with valves and allow to stand for 24 hours.
         2) Fill system or part thereof with water/chlorine solution with at least 200 ppm (200 mg/L) of chlorine. Isolate and allow to stand for three hours.
      c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
      d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

B. Prepare and submit reports of purging and disinfecting activities.

C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.18 PIPING SCHEDULE

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.

C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.

D. Under-building-slab, domestic water, building service piping, NPS 3 (DN 80) and smaller, shall be the following:

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1. Soft copper tube, ASTM B 88, Type K (ASTM B 88M, Type B); wrought-copper solder-joint fittings; and brazed joints.

E. Under-building-slab, domestic water, building-service piping, NPS 4 to NPS 8 (DN 100 to DN 200) and larger, shall be the following:
   1. Soft copper tube, ASTM B 88, Type K (ASTM B 88M, Type B); wrought-copper solder-joint fittings; and brazed joints.
   2. Mechanical-joint, ductile-iron pipe; standard- or compact-pattern mechanical-joint fittings; and mechanical joints.
   3. Push-on-joint, ductile-iron pipe; standard- or compact-pattern push-on-joint fittings; and gasketed joints.
   4. Plain-end, ductile-iron pipe; grooved-joint, ductile-iron-pipe appurtenances; and grooved joints.

F. Aboveground domestic water piping, NPS 2 (DN 50) and smaller, shall be the following:
   1. Galvanized-steel pipe and nipples; galvanized, gray-iron threaded fittings; and threaded joints.
   2. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); cast- or wrought-copper solder-joint fittings; and brazed or soldered joints.

G. Aboveground domestic water piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100), shall be the following:
   1. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); cast- or wrought-copper solder-joint fittings; and brazed or soldered joints.

3.19 VALVE SCHEDULE

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
   1. Shutoff Duty: Use ball or gate valves for piping NPS 2 (DN 50) and smaller. Use butterfly, ball, or gate valves with flanged ends for piping NPS 2-1/2 (DN 65) and larger.
   2. Throttling Duty: Use ball or globe valves for piping NPS 2 (DN 50) and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 (DN 65) and larger.
   3. Drain Duty: Hose-end drain valves.

B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

C. Iron grooved-end valves may be used with grooved-end piping.

D. PVC valves matching piping materials may be used.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following domestic water piping specialties:
1. Vacuum breakers.
2. Backflow preventers.
3. Water pressure-reducing valves.
4. Balancing valves.
5. Temperature-actuated water mixing valves.
6. Strainers.
7. Drain valves.
8. Water hammer arresters.
9. Air vents.

B. Related Sections include the following:
1. Division 22 Section "Domestic Water Piping" for water meters.

1.3 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 180 psig (550 kPa), unless otherwise indicated.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Field quality-control test reports.

C. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. NSF Compliance:
1. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic domestic water piping components.
2. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9."

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 2 - PRODUCTS

2.1 VACUUM BREAKERS

A. Pressure Vacuum Breakers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Ames Co.
   b. Conbraco Industries, Inc.
   c. FEBCO; SPX Valves & Controls.
   d. Toro Company (The); Irrigation Div.
   e. Watts Industries, Inc.; Water Products Div.
   f. Zurn Plumbing Products Group; Wilkins Div.
   g. Or approved equal.
2. Standard: ASSE 1020.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 5 psig (35 kPa) maximum, through middle 1/3 of flow range.
5. Accessories:
   a. Valves: Ball type, on inlet and outlet.

B. Laboratory-Faucet Vacuum Breakers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Conbraco Industries, Inc.
   b. Watts Industries, Inc.; Water Products Div.
   c. Woodford Manufacturing Company.
   d. Zurn Plumbing Products Group; Wilkins Div.
   e. Or approved equal.
2. Standard: ASSE 1035.
3. Size: NPS 1/4 or NPS 3/8 (DN 8 or DN 10) matching faucet size.
4. Body: Bronze.
5. End Connections: Threaded.
6. Finish: Chrome plated.

2.2 BACKFLOW PREVENTERS

A. Intermediate Atmospheric-Vent Backflow Preventers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Conbraco Industries, Inc.
   b. FEBCO; SPX Valves & Controls.
   c. Honeywell Water Controls.
   d. Legend Valve.
   e. Watts Industries, Inc.; Water Products Div.
   f. Zurn Plumbing Products Group; Wilkins Div.
   g. Or approved equal.
2. Standard: ASSE 1012.
3. Operation: Continuous-pressure applications.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

4. Size: Same as upstream pipe.
5. Body: Bronze.
6. End Connections: Union, solder joint.
7. Finish: Chrome plated.

B. Double-Check Backflow-Prevention Assemblies:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Ames Co.
   b. Conbraco Industries, Inc.
   c. FEBCO; SPX Valves & Controls.
   d. Watts Industries, Inc.; Water Products Div.
   e. Zurn Plumbing Products Group; Wilkins Div.
   f. Or approved equal.
2. Standard: ASSE 1015.
3. Operation: Continuous-pressure applications, unless otherwise indicated.
4. Pressure Loss: 5 psig (35 kPa) maximum, through middle 1/3 of flow range.
5. Size: As scheduled on drawings.
6. Design Flow Rate: As scheduled on drawings.
7. Body: Bronze for NPS 2 (DN 50) and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved for NPS 2-1/2 (DN 65) and larger.
8. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 (DN 65) and larger.
9. Accessories:
   a. Valves: Ball type with threaded ends on inlet and outlet ofNPS 2 (DN 50) and smaller; outside screw and yoke gate-type with flanged ends on inlet and outlet of NPS 2-1/2 (DN 65) and larger.

2.3 WATER PRESSURE-REDUCING VALVES

A. Water Regulators:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Conbraco Industries, Inc.
   b. Watts Industries, Inc.; Water Products Div.
   c. Zurn Plumbing Products Group; Wilkins Div.
   d. Or approved equal.
2. Standard: ASSE 1003.
3. Pressure Rating: Initial working pressure of 150 psig (1035 kPa).
4. Size: As scheduled on drawings.
5. Design Flow Rate: As scheduled on drawings.
6. Design Inlet Pressure: As scheduled on drawings.
7. Design Outlet Pressure Setting: As scheduled on drawings.
8. Body: Bronze with chrome-plated finish for NPS 2 (DN 50) and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved for NPS 2-1/2 and NPS 3 (DN 65 and DN 80).
9. Valves for Booster Heater Water Supply: Include integral bypass.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

10. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 and NPS 3 (DN 65 and DN 80).

B. Water Control Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. CLA-VAL Automatic Control Valves.
   b. Watts Industries, Inc.; Ames Fluid Control Systems.
   c. Watts Industries, Inc.; Watts ACV.
   d. Zurn Plumbing Products Group; Wilkins Div.
   e. Or approved equal.
2. Description: Pilot-operation, diaphragm-type, single-seated main water control valve.
3. Pressure Rating: Initial working pressure of 150 psig (1035 kPa) minimum with AWWA C550 or FDA-approved, interior epoxy coating. Include small pilot-control valve, restrictor device, specialty fittings, and sensor piping.
4. Main Valve Body: Cast- or ductile-iron body with AWWA C550 or FDA-approved, interior epoxy coating; or stainless-steel body.
   a. Size: As scheduled on drawings.
   b. Pattern: Globe-valve design.
   c. Trim: Stainless steel.
5. Design Flow: As scheduled on drawings.
6. Design Inlet Pressure: As scheduled on drawings.
7. Design Outlet Pressure Setting: As scheduled on drawings.
8. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 (DN 65) and larger.

2.4 BALANCING VALVES

A. Cast-Iron Calibrated Balancing Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Armstrong International, Inc.
   b. ITT Industries; Bell & Gossett Div.
   c. NIBCO INC.
   d. Watts Industries, Inc.; Water Products Div.
   e. Or approved equal.
2. Type: Adjustable with Y-pattern globe valve, two readout ports, and memory-setting indicator.
3. Size: Same as connected piping, but not smaller than NPS 2-1/2 (DN 65).

B. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

2.5 TEMPERATURE-ACTUATED WATER MIXING VALVES

A. Primary, Thermostatic, Water Mixing Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Armstrong International, Inc.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

b. Lawler Manufacturing Company, Inc.
c. Powers; a Watts Industries Co.
d. Symmons Industries, Inc.
e. Or approved equal.

2. Standard: ASSE 1017.
3. Pressure Rating: 125 psig (860 kPa).
4. Type: Exposed-mounting, thermostatically controlled water mixing valve.
5. Material: Bronze body with corrosion-resistant interior components.
6. Connections: Threaded union inlets and outlet.
7. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
8. Valve Pressure Rating: 125 psig (860 kPa) minimum, unless otherwise indicated.
9. Tempered-Water Setting: As indicated on drawings.
10. Tempered-Water Design Flow Rate: As indicated on drawings.
11. Valve Finish: Polished, chrome plated.
12. Piping Finish: Chrome plated.

2.6 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:
1. Pressure Rating: 125 psig (860 kPa) minimum, unless otherwise indicated.
2. Body: Bronze for NPS 2 (DN 50) and smaller; cast iron with interior lining complying with AWWA C550 or FDA-approved, epoxy coating and for NPS 2-1/2 (DN 65) and larger.
3. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 (DN 65) and larger.
4. Screen: Stainless steel with round perforations, unless otherwise indicated.
5. Perforation Size:
a. Strainers NPS 2 (DN 50) and Smaller: 0.033 inch (0.84 mm).
b. Strainers NPS 2-1/2 to NPS 4 (DN 65 to DN 100): 0.062 inch (1.57 mm).
c. Strainers NPS 5 (DN 125) and Larger: 0.125 inch (3.18 mm).
6. Drain: Pipe plug for strainers NPS 2 (DN 50) and smaller and factory-installed, hose-end drain valve for strainers NPS 2-1/2 (DN 65) and larger.

2.7 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:
1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
2. Pressure Rating: 400-psig (2760-kPa) minimum CWP.
3. Size: NPS 3/4 (DN 20).
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.
8. Inlet: Threaded or solder joint.
9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Gate-Valve-Type, Hose-End Drain Valves:
   1. Standard: MSS SP-80 for gate valves.
   2. Pressure Rating: Class 125.
   3. Size: NPS 3/4 (DN 20).
   4. Body: ASTM B 62 bronze.
   5. Inlet: NPS 3/4 (DN 20) threaded or solder joint.
   6. Outlet: Garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

C. Stop-and-Waste Drain Valves:
   1. Standard: MSS SP-110 for ball valves or MSS SP-80 for gate valves.
   2. Pressure Rating: 200-psig (1380-kPa) minimum CWP or Class 125.
   3. Size: NPS 3/4 (DN 20).
   4. Body: Copper alloy or ASTM B 62 bronze.
   5. Drain: NPS 1/8 (DN 6) side outlet with cap.

2.8 AIR VENTS

A. Welded-Construction Automatic Air Vents:
   1. Body: Stainless steel.
   2. Pressure Rating: 150-psig (1035-kPa) minimum pressure rating.
   3. Float: Replaceable, corrosion-resistant metal.
   4. Mechanism and Seat: Stainless steel.
   5. Size: NPS 3/8 (DN 10) minimum inlet.
   6. Inlet and Vent Outlet End Connections: Threaded.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.

B. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
   1. Locate backflow preventers in same room as connected equipment or system.
   2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.
   3. Do not install bypass piping around backflow preventers.

C. Install water regulators with inlet and outlet shutoff valves and bypass with memory-stop balancing valve. Install pressure gages on inlet and outlet.

D. Install water control valves with inlet and outlet shutoff valves and bypass with globe valve. Install pressure gages on inlet and outlet.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

E. Install balancing valves in locations where they can easily be adjusted.

F. Install temperature-actuated water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.
   1. Install thermometers and water regulators if specified.
   2. Install cabinet-type units recessed in or surface mounted on wall as specified.

G. Install Y-pattern strainers for water on supply side of each water pressure-reducing valve, solenoid valve, and pump.

H. Install air vents at high points of water piping. Install drain piping and discharge onto floor drain.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping and specialties.

3.3 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
   1. Intermediate atmospheric-vent backflow preventers.
   2. Reduced-pressure-principle backflow preventers.
   3. Double-check backflow-prevention assemblies.
   4. Reduced-pressure-detector, fire-protection backflow-preventer assemblies.
   5. Double-check, detector-assembly backflow preventers.
   6. Water pressure-reducing valves.
   7. Primary, thermostatic, water mixing valves.
   8. Manifold, thermostatic, water-mixing-valve assemblies.
   9. Photographic-process, thermostatic, water-mixing-valve assemblies.
   10. Primary water tempering valves.

B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and prepare test reports:
   1. Test each double-check backflow-prevention assembly according to authorities having jurisdiction and the device's reference standard.

B. Remove and replace malfunctioning domestic water piping specialties and retest as specified above.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3.5 ADJUSTING

A. Set field-adjustable pressure set points of water pressure-reducing valves.

B. Set field-adjustable flow set points of balancing valves.

C. Set field-adjustable temperature set points of temperature-actuated water mixing valves.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following for soil, waste, vent, and storm drainage piping inside the building:
   1. Pipe, tube, and fittings.
   2. Special pipe fittings.
   3. Encasement for underground metal piping.

1.3 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

1.4 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure, unless otherwise indicated:
   1. Drain and Vent Piping: 10-foot head of water (30 kPa).
   2. Force-Main Piping: 50 psig (345 kPa).

B. Seismic Performance: Drainage and vent piping and support and installation shall be capable of withstanding the effects of seismic events determined according to ASCE 7, "Minimum Design Loads for Buildings and Other Structures."

1.5 SUBMITTALS

A. Product Data: For pipe, tube, fittings, and couplings.

B. Shop Drawings:
   1. Design Calculations: Signed and sealed by a qualified professional engineer for selecting seismic restraints.

C. Field quality-control inspection and test reports.

1.6 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping; "NSF-drain" for plastic drain piping; "NSF-tubular" for plastic continuous waste piping; and "NSF-sewer" for plastic sewer piping.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 PIPING MATERIALS

A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.3 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 74, Service class(es).

B. Gaskets: ASTM C 564, rubber.

2.4 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 or CISPI 301.

B. Shielded Couplings: ASTM C 1277 assembly of metal shield or housing, corrosion-resistant fasteners, and rubber sleeve with integral, center pipe stop.
   1. Medium-Duty, Shielded, Stainless-Steel Couplings: With stainless-steel shield, stainless-steel bands and tightening devices, and ASTM C 564, rubber sleeve.
      a. Manufacturers:
         1) ANACO.
         2) Clamp-All Corp.
         3) Ideal Div.; Stant Corp.
         4) Mission Rubber Co.
         5) Tyler Pipe; Soil Pipe Div.
         6) Or approved equal.

2.5 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade A or B, Schedule 40, galvanized. Include ends matching joining method.

B. Drainage Fittings: ASME B16.12, galvanized, threaded, cast-iron drainage pattern.

C. Pressure Fittings:
   1. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, galvanized, seamless steel pipe. Include ends matching joining method.
   2. Malleable-Iron Unions: ASME B16.39; Class 150; hexagonal-stock body with ball-and-socket, metal-to-metal, bronze seating surface; and female threaded ends.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3. Gray-Iron, Threaded Fittings: ASME B16.4, Class 125, standard pattern.
4. Cast-Iron Flanges: ASME B16.1, Class 125.

2.6 SPECIAL PIPE FITTINGS

A. Flexible, Nonpressure Pipe Couplings: Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition pattern. Include shear ring, ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.
   1. Manufacturers:
      a. Fernco, Inc.
      b. Mission Rubber Co.
      c. Plastic Oddities, Inc.
      d. Or approved equal.
   2. Sleeve Materials:
      a. For Cast-Iron Soil Pipes: ASTM C 564, rubber.
      b. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
      c. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

B. Pressure Pipe Couplings: AWWA C219 metal, sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.
   1. Manufacturers:
      a. Cascade Waterworks Mfg. Co.
      b. Dresser, Inc.; DMD Div.
      c. Or approved equal.
   2. Center-Sleeve Material: Ductile iron.
   3. Gasket Material: Natural or synthetic rubber.
   4. Metal Component Finish: Corrosion-resistant coating or material.

C. Flexible Ball Joints: Ductile-iron fitting with combination of flanged and mechanical-joint ends complying with AWWA C110 or AWWA C153. Include gasketed ball-joint section and ductile-iron gland, rubber gasket, and steel bolts.
   1. Manufacturers:
      a. EBAA Iron Sales, Inc.
      b. Or approved equal.

D. Wall-Penetration Fittings: Compound, ductile-iron coupling fitting with sleeve and flexing sections for up to 20-degree deflection, gaskets, and restrained-joint ends complying with AWWA C110 or AWWA C153. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.
   1. Manufacturers:
      a. SIGMA Corp.
      b. Or approved equal.

2.7 ENCASEMENT FOR UNDERGROUND METAL PIPING

A. Description: ASTM A 674 or AWWA C105, high-density, crosslaminated PE film of 0.004-inch (0.10-mm) or LLDPE film of 0.008-inch (0.20-mm) minimum thickness.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Form: Tube.

C. Color: Black or natural.

PART 3 - EXECUTION

3.1 EXCAVATION

A. Refer to Division 31 Section "Site Excavation, Backfilling, and Compaction" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

A. Flanges and unions may be used on aboveground pressure piping, unless otherwise indicated.

B. Aboveground, drainage and vent piping NPS 1-1/4 (DN 32) and larger shall be any of the following:
1. Hubless cast-iron soil pipe and fittings medium-duty shielded, stainless-steel couplings; and hubless-coupling joints.
2. Dissimilar Pipe-Material Couplings: Flexible, nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.

C. Underground, drainage and vent piping NPS 2 (DN 50) and larger shall be any of the following:
1. Service class, cast-iron soil piping; gaskets; and gasketed joints.
2. Dissimilar Pipe-Material Couplings: Flexible, nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.

D. Aboveground drainage force mains NPS 4 (DN 100) and smaller shall be any of the following:
1. Steel pipe, pressure fittings, and threaded joints.

E. Underground sanitary-sewage force mains NPS 4 (DN 100) and smaller shall be any of the following:
1. Steel pipe, pressure fittings, and threaded joints.
2. Pressure pipe couplings, if dissimilar pipe materials or piping with small difference in OD must be joined.

3.3 PIPING INSTALLATION

A. Basic piping installation requirements are specified in Division 22 Section "Common Work Results for Plumbing."

B. Install seismic restraints on piping. Seismic-restraint devices are specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

C. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

D. Install cleanout fitting with closure plug inside the building in sanitary force-main piping.

E. Install underground, steel, force-main piping. Install encasement on piping according to ASTM A 674 or AWWA C105.

F. Install underground, copper, force-main tubing according to CDA's "Copper Tube Handbook."
   1. Install encasement on piping according to ASTM A 674 or AWWA C105.

G. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Sleeves and mechanical sleeve seals are specified in Division 22 Section "Common Work Results for Plumbing."

H. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

I. Make changes in direction for drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

J. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

K. Install drainage and vent piping at the following minimum slopes, unless otherwise indicated:
   1. Drainage Piping: 2 percent downward in direction of flow for piping NPS 2 (DN 50) and smaller; 1 percent downward in direction of flow for piping NPS 3 (DN 80) and larger.
   2. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

L. Install engineered soil and waste drainage and vent piping systems as follows:
   1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.

M. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.

N. Install underground PVC drainage piping according to ASTM D 2321.

O. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3.4 JOINT CONSTRUCTION

A. Basic piping joint construction requirements are specified in Division 22 Section "Common Work Results for Plumbing."

B. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

C. Join hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.

D. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

E. PVC Nonpressure Piping Joints: Join piping according to ASTM D 2665.

3.5 VALVE INSTALLATION

A. General valve installation requirements are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."

B. Shutoff Valves: Install shutoff valve on each sewage pump discharge.
   1. Install gate or full-port ball valve for piping NPS 2 (DN 50) and smaller.
   2. Install gate valve for piping NPS 2-1/2 (DN 65) and larger.

C. Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage or sump pump discharge.

D. Backwater Valves: Install backwater valves in piping subject to sewage backflow.
   1. Horizontal Piping: Horizontal backwater valves. Use normally closed type, unless otherwise indicated.
   2. Floor Drains: Drain outlet backwater valves, unless drain has integral backwater valve.
   3. Install backwater valves in accessible locations.
   4. Backwater valve are specified in Division 22 Section "Drainage Piping Specialities."

3.6 HANGER AND SUPPORT INSTALLATION

A. Seismic-restraint devices are specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Pipe hangers and supports are specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment." Install the following:
   1. Vertical Piping: MSS Type 8 or Type 42, clamps.
   2. Install individual, straight, horizontal piping runs according to the following:
      a. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
      b. Longer Than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.
      c. Longer Than 100 Feet (30 m), if Indicated: MSS Type 49, spring cushion rolls.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 1, adjustable, steel clevis hangers.

C. Install supports according to Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

D. Support vertical piping and tubing at base and at each floor.

E. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch (10-mm) minimum rods.

F. Install hangers for cast-iron drainage piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
2. NPS 3 (DN 80): 60 inches (1500 mm) with 1/2-inch (13-mm) rod.
3. NPS 4 and NPS 5 (DN 100 and DN 125): 60 inches (1500 mm) with 5/8-inch (16-mm) rod.
4. NPS 6 (DN 150): 60 inches (1500 mm) with 3/4-inch (19-mm) rod.
5. NPS 8 to NPS 12 (DN 200 to DN 300): 60 inches (1500 mm) with 7/8-inch (22-mm) rod.

G. Install supports for vertical cast-iron soil piping every 15 feet (4.5 m).

H. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/4 (DN 32): 84 inches (2100 mm) with 3/8-inch (10-mm) rod.
2. NPS 1-1/2 (DN 40): 108 inches (2700 mm) with 3/8-inch (10-mm) rod.
3. NPS 2 (DN 50): 10 feet (3 m) with 3/8-inch (10-mm) rod.
4. NPS 2-1/2 (DN 65): 11 feet (3.4 m) with 1/2-inch (13-mm) rod.
5. NPS 3 (DN 80): 12 feet (3.7 m) with 1/2-inch (13-mm) rod.
6. NPS 4 (DN 100): 12 feet (3.7 m) with 5/8-inch (16-mm) rod.

I. Install supports for vertical steel piping every 15 feet (4.5 m).

J. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/4 (DN 32): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
2. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
3. NPS 2-1/2 (DN 65): 108 inches (2700 mm) with 1/2-inch (13-mm) rod.
4. NPS 3 to NPS 4 (DN 80 to DN 100): 10 feet (3 m) with 1/2-inch (13-mm) rod.

K. Install supports for vertical copper tubing every 10 feet (3 m).

L. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3.7 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect interior drainage piping to exterior drainage piping. Use transition fitting to join dissimilar piping materials.

C. Connect sanitary drainage and vent piping to the following:
   1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
   2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
   3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
   4. Equipment: Connect drainage piping as indicated. Provide shutoff valve, if indicated, and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 (DN 65) and larger.

D. Connect storm drainage piping to roof drains and storm drainage specialties.

E. Connect force-main piping to the following:
   1. Sewer: To exterior force main or manhole.
   2. Sewage or Sump Pumps: To sewage or sump pump discharge.

3.8 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
   1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
   2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
   1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
   2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water (30 kPa). From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg (250 Pa). Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
2. Cap and subject piping to static-water pressure of 50 psig (345 kPa) above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
4. Prepare reports for tests and required corrective action.

3.9 CLEANING

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following drainage piping specialties:
   1. Backwater valves.
   2. Cleanouts.
   3. Channel drainage systems.
   4. Roof flashing assemblies.
   5. Through-penetration firestop assemblies.
   6. Miscellaneous drainage piping specialties.
   7. Flashing materials.
   8. Grease interceptors.
   9. Oil interceptors.
   10. Solids interceptors.

1.3 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. FOG: Fats, oils, and greases.

C. FRP: Fiberglass-reinforced plastic.

D. HDPE: High-density polyethylene plastic.

E. PE: Polyethylene plastic.

F. PUR: Polyurethane plastic.

G. PP: Polypropylene plastic.

H. PVC: Polyvinyl chloride plastic.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and accessories for the following:
   1. Grease interceptors.
   2. Oil interceptors.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Manufacturer Seismic Qualification Certification: Submit certification that grease interceptors, oil interceptors, accessories, and components will withstand seismic forces defined in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment." Include the following:
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
      a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For drainage piping specialties to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic sanitary piping specialty components.

1.6 COORDINATION

A. Coordinate size and location of roof penetrations.

PART 2 - PRODUCTS

2.1 BACKWATER VALVES

A. Horizontal, Cast-Iron Backwater Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Josam Company; Josam Div.
      b. MIFAB, Inc.
      c. Smith, Jay R. Mfr. Co.; Division of Smith Industries, Inc.
      d. Tyler Pipe; Wade Div.
      e. Watts Drainage Products Inc.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

f. Zurn Plumbing Products Group; Specification Drainage Operation.
g. Or approved equal.

2. Standard: ASME A112.14.1.
3. Size: Same as connected piping.
4. Body: Cast iron.
5. Cover: Cast iron with bolted or threaded access check valve.
6. End Connections: Hub and spigot.
7. Type Check Valve: Removable, bronze, swing check, factory assembled or field modified to hang closed.
8. Extension: ASTM A 74, Service class; full-size, cast-iron, soil-pipe extension to field-installed cleanout at floor; replaces backwater valve cover.

B. Drain-Outlet Backwater Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Josam Company; Josam Div.
b. Smith, Jay R. Mfr. Co.; Division of Smith Industries, Inc.
c. Watts Drainage Products Inc.
d. Zurn Plumbing Products Group; Specification Drainage Operation.
e. Or approved equal.
2. Size: Same as floor drain outlet.
3. Body: Cast iron or bronze made for vertical installation in bottom outlet of floor drain.
4. Check Valve: Removable ball float.
5. Inlet: Threaded.
6. Outlet: Threaded or spigot.

2.2 CLEANOUTS

A. Exposed Cleanouts:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Josam Company; Josam Div.
b. MIFAB, Inc.
c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
d. Tyler Pipe; Wade Div.
e. Watts Drainage Products Inc.
f. Zurn Plumbing Products Group; Specification Drainage Operation.
g. Or approved equal.
2. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
3. Size: Same as connected drainage piping.
4. Body Material: Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: Countersunk or raised-head plug.
6. Closure Plug Size: Same as cleanout size.

B. Floor Cleanouts:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Josam Company; Josam Div.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
c. Tyler Pipe; Wade Div.
d. Watts Drainage Products Inc.
e. Zurn Plumbing Products Group; Specification Drainage Operation.
f. Or approved equal.

2. Standard: ASME A112.36.2M for adjustable housing cleanout.
3. Size: Same as connected branch.
4. Type: Adjustable housing.
5. Body or Ferrule: Cast iron.
6. Outlet Connection: Spigot.
7. Closure: Brass plug with tapered threads.
8. Adjustable Housing Material: Cast iron with threads.
9. Frame and Cover Material and Finish: Polished bronze.
10. Frame and Cover Shape: Round.
11. Top Loading Classification: Medium Duty.
12. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.

C. Wall Cleanouts:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Josam Company; Josam Div.
b. MIFAB, Inc.
c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
d. Tyler Pipe; Wade Div.
e. Watts Drainage Products Inc.
f. Zurn Plumbing Products Group; Specification Drainage Operation.
g. Or approved equal.
2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
4. Body: Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: Countersunk or raised-head, drilled-and-threaded brass plug.
6. Closure Plug Size: Same as cleanout size.
7. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.

2.3 MISCELLANEOUS DRAINAGE PIPING SPECIALTIES

A. Open Drains:
1. Description: Shop or field fabricate from ASTM A 74, Service class, hub-and-spigot, cast-iron, soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C 564, rubber gaskets.
2. Size: Same as connected waste piping with increaser fitting on inlet.

B. Deep-Seal Traps:
1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
2. Size: Same as connected waste piping.
a. NPS 2 (DN 50): 4-inch- (100-mm-) minimum water seal.
b. NPS 2-1/2 (DN 65) and Larger: 5-inch- (125-mm-) minimum water seal.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

C. Floor-Drain, Trap-Seal Primer Fittings:
   1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
   2. Size: Same as floor drain outlet with NPS 1/2 (DN 15) side inlet.

D. Air-Gap Fittings:
   1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
   2. Body: Bronze or cast iron.
   3. Inlet: Opening in top of body.
   4. Outlet: Larger than inlet.
   5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

E. Sleeve Flashing Device:
   1. Description: Manufactured, cast-iron fitting, with clamping device that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 2 inches (51 mm) above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
   2. Size: As required for close fit to riser or stack piping.

F. Stack Flashing Fittings:
   1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
   2. Size: Same as connected stack vent or vent stack.

G. Expansion Joints:
   1. Standard: ASME A112.21.2M.
   2. Body: Cast iron with bronze sleeve, packing, and gland.
   3. End Connections: Matching connected piping.
   4. Size: Same as connected soil, waste, or vent piping.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.

B. Install backwater valves in building drain piping. For interior installation, provide cleanout deck plate flush with floor and centered over backwater valve cover, and of adequate size to remove valve cover for servicing.

C. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
   1. Size same as drainage piping up to NPS 4 (DN 100). Use NPS 4 (DN 100) for larger drainage piping unless larger cleanout is indicated.
   2. Locate at each change in direction of piping greater than 45 degrees.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3. Locate at minimum intervals of 50 feet (15 m) for piping NPS 4 (DN 100) and smaller and 100 feet (30 m) for larger piping.
4. Locate at base of each vertical soil and waste stack.

D. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

E. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

F. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
1. Position floor drains for easy access and maintenance.
2. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
3. Install individual traps for floor drains connected to sanitary building drain.

G. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions. Roofing materials are specified in Division 07.
1. Install roof-drain flashing collar or flange so that there will be no leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
2. Position roof drains for easy access and maintenance.

H. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.

I. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.

J. Assemble open drain fittings and install with top of hub 1 inch (25 mm) above floor.

K. Install deep-seal traps on floor drains and other waste outlets, if indicated.

L. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.
1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
2. Size: Same as floor drain inlet.

M. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

N. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.

O. Install expansion joints on vertical stacks and conductors where indicated. Position expansion joints for easy access and maintenance.

P. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

Q. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

3.3 FLASHING INSTALLATION

A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required.

B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches (250 mm), and skirt or flange extending at least 8 inches (200 mm) around pipe.
2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches (200 mm) around sleeve.
3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches (200 mm) around specialty.

C. Secure flashing into sleeve and specialty clamping ring or device.

D. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Division 07 Section.

3.4 PROTECTION

A. Protect drains during construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following electric water heaters:
   1. Thermostat-control, instantaneous electric water heaters.
   2. Commercial, storage electric water heaters.
   3. Industrial, storage electric water heaters for hazardous locations.
   4. Water heater accessories.

1.3 SUBMITTALS

A. Product Data: For each type and size of water heater indicated. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Product Certificates: For each type of commercial and instantaneous electric water heater, signed by product manufacturer.

D. Manufacturer Seismic Qualification Certification: Submit certification that commercial water heaters, accessories, and components will withstand seismic forces defined in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment." Include the following:
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
      a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Source quality-control test reports.

F. Field quality-control test reports.

G. Operation and Maintenance Data: For electric water heaters to include in emergency, operation, and maintenance manuals.

H. Warranty: Special warranty specified in this Section.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain same type of electric water heaters through one source from a single manufacturer.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of electric water heaters and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. ASME Compliance: Where indicated, fabricate and label commercial water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

E. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9," for all components that will be in contact with potable water.

1.5 COORDINATION

A. Coordinate size and location of concrete bases with Architectural and Structural Drawings.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of electric water heaters that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Structural failures including storage tank and supports.
      b. Faulty operation of controls.
      c. Deterioration of metals, metal finishes, and other materials beyond normal use.
   2. Warranty Period(s): From date of Substantial Completion:
      a. Instantaneous Electric Water Heaters: Five years.
      b. Commercial Electric Water Heaters:
         1) Storage Tank: Five years.
         2) Controls and Other Components: Five years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2.2 COMMERCIAL ELECTRIC WATER HEATERS

A. Commercial, Storage Electric Water Heaters: Comply with UL 1453 requirements for storage-tank-type water heaters.
   1. Manufacturers:
      a. Lochinvar Corporation.
      b. Smith, A. O. Water Products Company.
      c. State Industries, Inc.
      d. Or approved equal.
   2. Storage-Tank Construction: ASME-code, steel vertical arrangement.
      a. Tappings: Factory fabricated of materials compatible with tank and piping connections. Attach tappings to tank before testing.
         1) NPS 2 (DN 50) and Smaller: Threaded ends according to ASME B1.20.1.
         2) NPS 2-1/2 (DN 65) and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.
      b. Pressure Rating: 150 psig (1035 kPa).
      c. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending lining material into tappings.
   3. Factory-Installed Storage-Tank Appurtenances:
      a. Anode Rod: Replaceable magnesium.
      b. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
      c. Insulation: Comply with ASHRAE/IESNA 90.1.
      d. Jacket: Steel with enameled finish.
      e. Heating Elements: Electric, screw-in or bolt-on immersion type arranged in multiples of three.
         1) Staging: Input not exceeding 18 kW per step.
      f. Temperature Control: Adjustable thermostat.
      g. Safety Controls: High-temperature-limit and low-water cutoff devices or systems.
      h. Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3, for combination temperature and pressure relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.
   4. Special Requirements: NSF 5 construction.
   5. Energy Management System Interface: Normally closed dry contacts for enabling and disabling water heater.

2.3 INDUSTRIAL ELECTRIC WATER HEATERS FOR HAZARDOUS LOCATIONS

A. Storage Electric Water Heaters: Comply with UL 1453, Requirements for Storage-Tank-Type Water Heaters and with UL and CSA ratings for operation in Class I, Division I areas.
   1. Manufacturers:
      a. Hubbell.
      b. Or approved equal.
   2. Storage-Tank Construction: ASME-Code, steel vertical arrangement.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

a. Tappings: Copper-silicon alloy tappings (non-ferrous); attach to tank before testing.
b. Pressure Rating: 150 psig.
c. Comply with NSF 61, Barrier Materials for Potable Water Tank Linings, including extending lining material into tappings.

3. Factory-Installed Storage Tank Appurtenances:
a. Anode Rod: Or replaceable magnesium.
b. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
c. Insulation: Comply with ASHRAE/IESNA 90.1.
d. Jacket: High-impact composite material.
e. Temperature Control: Adjustable thermostat.
f. Safety Controls: High-temperature-limit and low-water cutoff devices or systems.
g. Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3, for combination temperature and pressure relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.

2.4 WATER HEATER ACCESSORIES

A. Combination Temperature and Pressure Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3. Include relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.

B. Pressure Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3. Include pressure setting less than water heater working-pressure rating.

C. Water Heater Stand and Drain-Pan Units: High-density-polyethylene-plastic, 18-inch- (457-mm-) high, enclosed-base stand complying with IAPMO PS 103 and IAS No. 2. Include integral or separate drain pan with raised edge and NPS 1 (DN 25) drain outlet with ASME B1.20.1 pipe thread.

D. Water Heater Stands: Water heater manufacturer's factory-fabricated steel stand for floor mounting and capable of supporting water heater and water. Include dimension that will support bottom of water heater a minimum of 18 inches (457 mm) above the floor.

E. Water Heater Mounting Brackets: Water heater manufacturer's factory-fabricated steel bracket for wall mounting and capable of supporting water heater and water.

F. Drain Pans: Corrosion-resistant metal with raised edge. Include dimensions not less than base of water heater and include drain outlet not less than NPS 3/4 (DN 20).

G. Piping Manifold Kits: Water heater manufacturer's factory-fabricated inlet and outlet piping arrangement for multiple-unit installation. Include piping and valves for field assembly that are capable of isolating each water heater and of providing balanced flow through each water heater.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

H. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1 or ASHRAE 90.2.

I. Water Regulators: ASSE 1003, water-pressure reducing valve. Set at 25-psig- (172.5-kPa-) maximum outlet pressure, unless otherwise indicated.

J. Shock Absorbers: ASSE 1010 or PDI WH 201, Size A water hammer arrester.

2.5 SOURCE QUALITY CONTROL

A. Test and inspect water heater storage tanks, specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.

B. Hydrostatically test commercial water heater storage tanks before shipment to minimum of one and one-half times pressure rating.

C. Prepare test reports.

PART 3 - EXECUTION

3.1 WATER HEATER INSTALLATION

A. Install water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.

B. Install seismic restraints for commercial water heaters. Anchor to substrate.

C. Install combination temperature and pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

D. Install combination temperature and pressure relief valves in water piping for water heaters without storage. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

E. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for water heaters that do not have tank drains. Refer to Division 22 Section "Domestic Water Piping Specialties" for hose-end drain valves.

F. Install thermometer on outlet piping of water heaters.

G. Assemble and install inlet and outlet piping manifold kits for multiple water heaters. Fabricate, modify, or arrange manifolds for balanced water flow through each water heater.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

Include shutoff valve, thermometer in each water heater inlet and outlet, and throttling valve in each water heater outlet. Refer to Division 22 Section "General-Duty Valves for Plumbing Piping" for general-duty valves.

H. Install water regulator, with integral bypass relief valve, in booster-heater inlet piping and water hammer arrester in booster-heater outlet piping.

I. Install piping-type heat traps on inlet and outlet piping of water heater storage tanks without integral or fitting-type heat traps.

J. Fill water heaters with water.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to water heaters to allow service and maintenance. Arrange piping for easy removal of water heaters.

C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:
   1. Leak Test: After installation, test for leaks. Repair leaks and retest until no leaks exist.
   2. Operational Test: After electrical circuitry has been energized, confirm proper operation.
   3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace water heaters that do not pass tests and inspections and retest as specified above.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain commercial and instantaneous electric water heaters. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following plumbing fixtures and related components:
   1. Fixture supports.
   2. Service sinks.

B. Related Sections include the following:
   1. Division 22 Section "Domestic Water Piping Specialties" for backflow preventers.

1.3 DEFINITIONS

A. Accessible Plumbing Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.

B. Fitting: Device that controls the flow of water into or out of the plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads, drains and tailpieces, and traps and waste pipes.

C. FRP: Fiberglass-reinforced plastic.

D. PMMA: Polymethyl methacrylate (acrylic) plastic.

E. Accessible Fixture: Emergency plumbing fixture that can be approached, entered, and used by people with disabilities.

F. Plumbed Emergency Plumbing Fixture: Fixture with fixed, potable-water supply.

G. Self-Contained Emergency Plumbing Fixture: Fixture with flushing-fluid-solution supply.

H. Tepid: Moderately warm.

1.4 SUBMITTALS

A. Product Data: For each type of plumbing fixture indicated. Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports. Indicate materials and finishes, dimensions, construction details, and flow-control rates.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Operation and Maintenance Data: For plumbing fixtures to include in emergency, operation, and maintenance manuals.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.
   1. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.

D. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

E. Select combinations fixtures and trim, faucets, fittings, and other components that are compatible.

F. Comply with the following applicable standards and other requirements specified for plumbing fixtures:
   1. Enameled, Cast-Iron Fixtures: ASME A112.19.1M.
   2. Hand Sinks: NSF 2 construction.
   3. Plastic Bathtubs: ANSI Z124.1.
   4. Plastic Mop-Service Basins: ANSI Z124.6.
   5. Plastic Shower Enclosures: ANSI Z124.2.
   6. Porcelain-Enameled, Formed-Steel Fixtures: ASME A112.19.4M.
   7. Vitreous-China Fixtures: ASME A112.19.2M.
   8. Water-Closet, Flush Valve, Tank Trim: ASME A112.19.5.

G. Comply with the following applicable standards and other requirements specified for lavatory and sink faucets:
   1. Faucets: ASME A112.18.1.
   2. Integral, Atmospheric Vacuum Breakers: ASSE 1001.
   3. NSF Materials: NSF 61.
   4. Pipe Threads: ASME B1.20.1.
   5. Supply Fittings: ASME A112.18.1.
   6. Brass Waste Fittings: ASME A112.18.2.
   7. Supply and Drain Fittings: ASME A112.18.1M.

H. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:
   1. Atmospheric Vacuum Breakers: ASSE 1001.
   2. Brass and Copper Supplies: ASME A112.18.1.
   3. Flexible Water Connectors: ASME A112.18.6.
   4. Manual-Operation Flushometers: ASSE 1037.
   5. Brass Waste Fittings: ASME A112.18.2.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

I. Comply with the following applicable standards and other requirements specified for miscellaneous components:
   1. Floor Drains: ASME A112.21.1M.
   2. Grab Bars: ASTM F 446.
   3. Off-Floor Fixture Supports: ASME A112.6.1M.
   4. Pipe Threads: ASME B1.20.1.
   5. Plastic Toilet Seats: ANSI Z124.5.
   6. Plastic Shower Receptors: ANSI Z124.2.

PART 2 - PRODUCTS

Materials, piping, equipment shall be of domestic/NAFTA origin and manufacture, unless otherwise specified.

2.1 ACCEPTABLE MANUFACTURERS - VITREOUS CHINA AND ENAMELED CAST IRON FIXTURES

A. Kohler Company.

B. American Standard.

C. Eljer.

D. Crane.

E. Or approved equal.

2.2 ACCEPTABLE MANUFACTURERS - FIXTURE TRIM FAUCETS

A. Chicago Faucet Company.

B. T. and S. Brass and Bronze Works, Inc.

C. Kohler.

D. Speakman.

E. Zurn.

F. Eljer.

G. American Standard.

H. Delta Commercial.

I. Or approved equal.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2.3 ACCEPTABLE MANUFACTURERS - FIXTURE TRIM (BELOW FLOOD RIM)

A. Engineered Brass Company.

B. McGuire Manufacturing Company, Inc.

C. Chicago Faucet Company.

D. T. and S. Brass and Bronze Works, Inc.

E. Cambridge Brass.

F. Brass Craft.

G. Or approved equal.

2.4 ACCEPTABLE MANUFACTURERS - FLUSH VALVES

A. Sloan Valve Company.

B. Coyne and Delany Company.

C. Zurn Industries, Inc.

D. Cambridge Brass.

E. Or approved equal.

2.5 ACCEPTABLE MANUFACTURERS - FIXTURE CARRIERS AND SUPPORTS

A. Jay R. Smith Manufacturing, Inc.

B. Zurn Industries, Inc.

C. Wade Division/Tyler Pipe.

D. Josam Manufacturing.

E. MiFab.

F. Or approved equal.

2.6 ACCEPTABLE MANUFACTURERS - MIXING VALVES (THERMOSTATIC)

A. Symmons Industries, Inc.

B. Leonard Valve Company.

C. Powers.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

D. Holby.

E. Or approved equal.

2.7 ACCEPTABLE MANUFACTURERS - MIXING VALVES (PRESSURE BALANCED)

A. Symmons Industries, Inc.

B. Leonard Valve Company.

C. Powers.

D. Kohler Company.

E. Delta Commercial.

F. Or approved equal.

2.8 ACCEPTABLE MANUFACTURERS - STAINLESS STEEL SINKS

A. Just Manufacturing Company.

B. Elkay Manufacturing Company.

C. Kohler Company.

D. Or approved equal.

2.9 ACCEPTABLE MANUFACTURERS - SERVICE FLOOR BASINS

A. Stern-Williams Company, Inc.

B. Creative Industries Terrazzo Products, Inc.

C. Fiat Products, Inc.

D. Acorn Terrazzo Ware.

E. Or approved equal.

2.10 ACCEPTABLE MANUFACTURERS - LAUNDRY SINKS

A. Fiat Products, Inc.

B. Creative Industries Terrazzo Products, Inc.

C. Florestone Products Company, Inc.

D. Or approved equal.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2.11 ACCEPTABLE MANUFACTURERS - ROOF DRAINS, DECK DRAINS, WATER HYDRANTS, WALL HYDRANTS, FLOOR DRAINS, AREA DRAINS, INTERCEPTORS, FIXTURE CARRIERS, WATER HAMMER ARRESTORS (SHOCK ABSORBERS), AND ASSOCIATED ITEMS

A. Jay R. Smith Manufacturing, Inc.

B. Wade Division/Tyler Pipe.

C. Josam Manufacturing.

D. Zurn Industries, Inc.

E. Watts (Shock Absorbers)

F. Plastic Oddities, Inc. (for floor drains only)

G. MiFab.

H. Or approved equal.

2.12 ACCEPTABLE MANUFACTURERS – SECURITY PLUMBING FIXTURES

A. Accorn Engineering.

B. Bradley Corporation.

C. Metacraft, Inc.

D. Willoughby Industries.

E. Or approved equal.

2.13 ACCEPTABLE MANUFACTURERS – ELECTRIC WATER COOLERS

A. Filtrine Manufacturing Company.

B. Halsey Taylor.

C. Haws Corporation.

D. Murdock, Inc.

E. Oasis Corporation.

F. Stern-Williams Company, Inc.

G. Sunroc Corporation.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

H. Or approved equal.

2.14 PLUMBING FIXTURES

NOTE: All plumbing fixtures specified are derived from GS&P Master Plumbing Fixture Specifications. Any skips in fixture specification numbers is intentional and denotes those fixtures are not required for this particular project.

A. "P" NUMBERS LIST

1. P-506 UTILITY SINK (FLOOR MOUNTED)
   a. Fiat Products number FL1, molded stone, 23 inches by 21-1/2 inches, floor mounted single compartment laundry sink with four (4) support legs and floor anchors.
   b. One (1) Fiat Products number A-2, overflow pipe stand with strainer and 1-1/2 inch tailpiece.
   c. Fiat Products number FLTD, molded stone, 45-1/8 inches by 21-3/8 inches, floor mounted double compartment laundry sink with four (4) support legs and floor anchors.
   d. Two (2) Fiat Products number A-2, overflow pipe stand with strainer and 1-1/2 inch tailpiece.
   e. One (1) Fiat Products number A-3, faucet block.
   f. One (1) Chicago Faucet number 772-DJ13, faucet with double jointed swing spout.
   g. One (1) EBC, Inc. number TA150, 1-1/2 inch semi-cast brass P-trap with cleanout plug.
   h. One (1) EBC, Inc. number WE149L16, 1-1/2 inch continuous waste with required end outlet length.
   i. One (1) pair EBC, Inc. number LA(H)12, supplies with wheel handle stop.

2. P-720 AUTOMATIC TRAP PRIMER (FLOOR DRAIN CONNECTION)
   a. Precision Plumbing Products, Inc. number HP-1 and/or HP-2, sized as required for the number of floor drains served. Refer to Contract Drawings for exact requirements.
   b. Unit(s) shall include trap primer valve and required distribution unit.
   c. Install to absolutely rigid condition.

3. P-724 WATER HAMMER ARRESTOR (SHOCK ABSORBER)
   a. Josam number 75001 thru 75006 or J.R. Smith number 5005 thru 5050, sized, installed and located as suggested by manufacturer.
   b. Installation of water hammer arrestors (shock absorbers) shall conform with Federal, State, and local code requirements. Provide wall access panel at each installation if code required.
   c. Install water hammer arrestors on supply piping for all scrub sinks, sterilizers, dishwashers, lavatories/sinks with foot pedals or sensor faucets, bath/toilet groups (back-to-back groups on same branch considered as one group), public toilet groups (sized per fixture unit rating), spray and quick closing devices.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

d. I.P.S. units only.
e. Refer to other sections of this specification for specified access panel requirements.

4. P-726 WALL HYDRANT (NON-FREEZE)
   a. Josam number 71050 "Line-Gard" or J.R. Smith number 5609QT, all bronze non-freeze wall hydrant, with satin nickel plated head, hose connection, integral vacuum breaker.
   b. Mounting height of 18 inches from hydrant centerline to finished exterior grade.

5. P-735 HOSE BIBB
   a. Arrowhead Brass model 351BFP-LK brass no-kink hose bibb with threaded hose connection, integral vacuum breaker, and loose-key handle.
   b. Mounting height of 18 inches from hose outlet to finished exterior grade.

6. P-810 FLOOR DRAIN (EQUIPMENT ROOMS, FULL GRATE)
   a. Josam number 32320-20-Y or J.R. Smith number 2233LXH-PB, cast iron floor drain with sediment bucket with lift bar, collar, and polished bronze top.
   b. Furnish and install clamp device if drain is installed in floor above slab on grade.
   c. Furnish and install required deep seal P-trap.
   d. Refer to Contract Drawings for drain size.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for plumbing fixtures to verify actual locations of piping connections before fixture installation.

B. Examine cabinets, counters, floors, and walls for suitable conditions where fixtures will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Assemble plumbing fixtures, trim, fittings, and other components according to manufacturers' written instructions.

B. Install off-floor supports, affixed to building substrate, for wall-mounting fixtures.
   1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
   2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
   3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.

C. Install back-outlet, wall-mounting fixtures onto waste fitting seals and attach to supports.

D. Install floor-mounting fixtures on closet flanges or other attachments to piping or building substrate.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

E. Install wall-mounting fixtures with tubular waste piping attached to supports.

F. Install counter-mounting fixtures in and attached to casework.

G. Install fixtures level and plumb according to roughing-in drawings.

H. Install water-supply piping with stop on each supply to each fixture to be connected to domestic water piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.
   1. Exception: Use ball, gate, or globe valve if stops are not specified with fixture. Valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."

I. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.

J. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

K. Install traps on fixture outlets.
   1. Exception: Omit trap on fixtures with integral traps.

L. Install escutcheons at piping wall penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Escutcheons are specified in Division 22 Section "Common Work Results for Plumbing."

M. Set showers in leveling bed of cement grout. Grout is specified in Division 22 Section "Common Work Results for Plumbing."

N. Seal joints between fixtures and walls, floors, and counters using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 07 Section "Joint Sealants."

O. Install floor-mounting, back-outlet water closets attached to building floor substrate and wall bracket and onto waste fitting seals.

P. Install tanks for accessible, tank-type water closets with lever handle mounted on wide side of compartment.

Q. Install water-supply, flow-control fittings with specified flow rates in fixture supplies at stop valves.

R. Install faucet, flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

S. Install hot-water dispensers in back top surface of sink or in counter with spout over sink.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

T. Seal joints between fixtures and walls, floors, and counters using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Refer to Division 7 Section "Joint Sealants" for sealant and installation requirements.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect water supplies from domestic water piping to plumbing fixtures.

C. Connect drain piping from plumbing fixtures to sanitary waste and vent piping.

D. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

E. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Verify that installed plumbing fixtures are categories and types specified for locations where installed.

B. Check that plumbing fixtures are complete with trim, faucets, fittings, and other specified components.

C. Inspect installed plumbing fixtures for damage. Replace damaged fixtures and components.

D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

E. Install fresh batteries in sensor-operated mechanisms.

3.5 ADJUSTING

A. Operate and adjust faucets and controls. Replace damaged and malfunctioning plumbing fixtures, fittings, and controls.

B. Adjust water pressure at faucets, shower valves, and flushometer valves to produce proper flow and stream.

C. Replace washers and seals of leaking and dripping faucets and stops.

3.6 CLEANING

A. Clean plumbing fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
2. Remove sediment and debris from drains.

B. After completing installation of exposed, factory-finished fixtures, faucets, and fittings, inspect exposed finishes and repair damaged finishes.

3.7 PROTECTION

A. Provide protective covering for installed fixtures and fittings.

B. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
1. Piping materials and installation instructions common to most piping systems.
2. Access doors.
3. Transition fittings.
4. Dielectric fittings.
5. Mechanical sleeve seals.
6. Sleeves.
7. Escutcheons.
8. Grout.
9. V-belt drives.
10. Bearings.
11. Fan, relief, and intake curb.
12. Mechanical demolition.
13. Equipment installation requirements common to equipment sections.
14. Workmanship.
15. Correction of work.
16. Coordination assistance.
17. Utilities excavation and backfilling.
18. Cutting and patching.
19. Counter flashing.
20. Connection of equipment furnished by Owner (others).
21. Service of systems.
22. Painting and finishing.
23. Concrete bases.
24. Supports and anchorages.
25. Acceptance of systems.
26. Warranty service.
27. Cleaning.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for plastic materials:
   1. ABS: Acrylonitrile-butadiene-styrene plastic.
   2. CPVC: Chlorinated polyvinyl chloride plastic.
   3. PE: Polyethylene plastic.
   4. PVC: Polyvinyl chloride plastic.

G. The following are industry abbreviations for rubber materials:
   1. EPDM: Ethylene-propylene-diene terpolymer rubber.
   2. NBR: Acrylonitrile-butadiene rubber.

H. Where reference is made to Architect it shall also mean Architect/Engineer.

I. Mechanical implies HVAC, plumbing, fire protection and medical gas systems.

1.4 LOCAL CONDITIONS

A. Conform with and to local conditions. Coordinate with local utilities on size of required utilities, services, and pay all associated fees required for such services.

1.5 INTENT

A. The specifications and drawings are complimentary. If one indicates a requirement then both have the same requirement. If there is a discrepancy it must be reported to the Architect for his resolution and instructions.

1.6 QUALITY ASSURANCE

A. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
   1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
   2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
   3. Maintain copy of welders certificates on project site.

B. Electrical Characteristics for Mechanical Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

C. Use care in loading, unloading, transport and storage of products, items and materials to keep said products, items and materials from damage.

D. Replace with new products, items or materials that become damaged.

E. Storage products, items, and materials from weather in a clean and dry place.

1.8 COORDINATION

A. Visit the site to be informed of conditions under which work must be performed. No subsequent allowance will be made because of error or failure to obtain necessary information to completely estimate and perform the work shown on the Contract Documents, specified and/or involved.

B. Carefully examine specifications and drawings to be thoroughly familiar with items which require mechanical, plumbing, fire protection, medical gases connections and coordination.

C. Notify related trades of any deviations or special conditions necessary for installation of work. Resolve interferences between work of various trades prior to installation. Remedial work due to lack of coordination or conformance with the Contract Documents shall be made at no additional cost to the Contract.

D. Provide “right-of-way” to piping which must slope for drainage.

E. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for mechanical installations.

F. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

G. Coordinate requirements for access panels and doors for mechanical items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08.

1.9 RECORD DRAWINGS

A. Keep a record set of Contract Documents at the job site exclusively for recording deviations from those drawings which are necessary because of job conditions. Record locations and depths of buried and concealed mechanical work by indicating top depths of buried mechanical work and the distances from fixed, easily identifiable objects such as building

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

walls or columns. Where pipes are concealed in walls, indicate distances off of building corners or other building features not likely to be disturbed by future alterations. Mark deviations in colored pencils so that work of various systems can be easily identified. Deliver this set to the Owner's Representative upon completion of "B" below.

B. When work is completed, record all deviations on clean sepia copies of drawings and submit sepias of completed "record drawings" to Owner's Representative for distribution.

1.10 PROCEDURES

A. General: Refer to Division 01.

B. Emergency Contacts: Along with the operating and maintenance manual submittal, provide the Owner with a list of the names and emergency telephone and beeper numbers of individuals who can be contacted during working and non-working hours, including weekends, for assistance throughout the warranty period should leaks, equipment failure or other damage occur. Update the list throughout warranty to provide continuous availability of responsible parties to the Owner. If the Owner cannot contact the responsible party during an emergency situation, the Owner may affect emergency repairs through other means and may backcharge the Contractor for the costs of repair material and labor incurred.

C. Equipment Cleaning: Thoroughly clean equipment and entire piping and duct systems internally upon completion of installation and immediately prior to final acceptance. Open dirt pockets and strainers, blow down each hydronic piping systems and clean strainer screens of accumulated debris. Remove accumulated dirt, scale, oil and foreign substances.

D. Filter Replacement: Clean heating and air conditioning equipment, tanks, pumps, traps, etc. and install new filters or filter media. Provide construction filters for the operation of heating, ventilation, and cooling units. Clean filters will be required for test and balance of the air side equipment.

E. Protection of Finished Installation: Where installation is required in areas previously finished by other trades, the area shall be protected from marring, soiling or other damage. Close open ends of ductwork, piping and equipment with temporary covers or plugs during construction to prevent entry of water and debris.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2.2 ACCESS DOORS AND PANELS

A. Locations: Provide access doors for concealed items and which require service or maintenance or other reason for accessibility.

B. Furnish ceiling and wall access panels for installation by other divisions. Coordinate locations to provide proper access of equipment or item to be accessed. Size to allow service of item being accessed, minimum size 12" x 12". Provide a minimum of 16 inch x 24 inch when a person must pass through the access opening.

2.3 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.4 JOINING MATERIALS

A. Refer to individual Division 23 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
   1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch(3.2-mm) maximum thickness unless thickness or specific material is indicated.
      a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
      b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
   2. AWWA C110, rubber, flat face, 1/8 inch(3.2 mm) thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

H. Solvent Cements for Joining Plastic Piping:
   1. ABS Piping: ASTM D 2235.
   2. CPVC Piping: ASTM F 493.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
4. PVC to ABS Piping Transition: ASTM D 3138.

I. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

2.5 TRANSITION FITTINGS

A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.
1. Manufacturers:
   a. Cascade Waterworks Mfg. Co.
   b. Dresser Industries, Inc.; DMD Div.
   c. Ford Meter Box Company, Incorporated (The); Pipe Products Div.
   d. JCM Industries.
   e. Smith-Blair, Inc.
   f. Viking Johnson.
   g. Or approved equal.
2. Underground Piping NPS 1-1/2(DN 40) and Smaller: Manufactured fitting or coupling.
3. Underground Piping NPS 2(DN 50) and Larger: AWWA C219, metal sleeve-type coupling.
4. Aboveground Pressure Piping: Pipe fitting.

B. Plastic-to-Metal Transition Fittings: PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
1. Manufacturer:
   a. Eslon Thermoplastics.
   b. Or approved equal.

C. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
1. Manufacturer:
   a. Thompson Plastics, Inc.
   b. Or approved equal.

D. Plastic-to-Metal Transition Unions: MSS SP-107, PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.
1. Manufacturers:
   a. NIBCO Inc.
   b. Or approved equal.

E. Flexible Transition Couplings for Underground Nonpressure Drainage Piping: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.
1. Manufacturers:
   a. Cascade Waterworks Mfg. Co.
   b. Fernco, Inc.
   c. Mission Rubber Company.
   d. Plastic Oddities, Inc.
   e. Or approved equal.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2.6 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions: Factory-fabricated, union assembly, for 150-psig(1035-kPa) minimum working pressure at 180 deg F(82 deg C).
   1. Manufacturers:
      a. Capitol Manufacturing Co.
      b. Central Plastics Company.
      c. Eclipse, Inc.
      d. Epco Sales, Inc.
      e. Hart Industries, International, Inc.
      f. Watts Industries, Inc.; Water Products Div.
      g. Zurn Industries, Inc.; Wilkins Div.
      h. Or approved equal.

D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150-psig (1035-kPa) minimum working pressure as required to suit system pressures.
   1. Manufacturers:
      a. Capitol Manufacturing Co.
      b. Central Plastics Company.
      c. Epco Sales, Inc.
      d. Watts Industries, Inc.; Water Products Div.
      e. Or approved equal.

E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
   1. Manufacturers:
      a. Advance Products & Systems, Inc.
      b. Calpico, Inc.
      c. Central Plastics Company.
      d. Pipeline Seal and Insulator, Inc.
      e. Or approved equal.
   2. Separate companion flanges and steel bolts and nuts shall have 150-psig (1035-kPa) minimum working pressure where required to suit system pressures.

F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 150-psig(1035-kPa) minimum working pressure at 225 deg F(107 deg C).
   1. Manufacturers:
      a. Calpico, Inc.
      b. Lochinvar Corp.
      c. Or approved equal.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

G. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 150-psig(1035-kPa) minimum working pressure at 225 deg F(107 deg C).
   1. Manufacturers:
      a. Perfection Corp.
      b. Precision Plumbing Products, Inc.
      c. Sioux Chief Manufacturing Co., Inc.
      d. Victaulic Co. of America.
      e. Or approved equal.

2.7 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
   1. Manufacturers:
      a. Advance Products & Systems, Inc.
      b. Calpico, Inc.
      c. Metraflex Co.
      d. Pipeline Seal and Insulator, Inc.
      e. Thunderline Industries.
      f. Or approved equal.
   2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   3. Pressure Plates: Stainless steel. Include two for each sealing element.
   4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.8 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch(0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.

B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
   1. Underdeck Clamp: Clamping ring with set screws.

E. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.

F. PVC Pipe: ASTM D 1785, Schedule 40.

G. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2.9 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Cast-Brass Type: With set screw.
1. Finish: Polished chrome-plated.

D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
1. Finish: Polished chrome-plated.

E. One-Piece, Floor-Plate Type: Cast-iron floor plate.

F. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

2.10 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi(34.5-MPa), 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

2.11 V-BELT DRIVE

A. General: Each motor driven piece of equipment not direct connected shall be provided with a V-belt drive. Belts shall fit properly in sheave grooves and carefully matched for each drive. Drive rating shall be as recommended by the manufacturer for service but shall be at least 1.5 times the nameplate rating of motor.

B. Fan Belt Drives: Provide adjustable pitch sheaves to allow test and balance and determine the required fixed sheave size. Then provide fixed pitch sheaves. Sheave-to-sheave centerline distances shall not exceed 3 times the sum of the sheave diameters, and shall not be less than the diameter of the larger sheave.

2.12 BELT AND COUPLING GUARDS

A. Belt and Coupling Guards: Each belt drive shall be equipped with an OSHA approved guard. Guards shall allow for movement of motor required to adjust belt tension. Provide means for oiling, use of tachometers, and other maintenance and testing operations with guard in place.

B. Direct Driven Equipment: Direct-drive motor driven equipment shall have coupling guards in accordance with OSHA Regulations.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2.13 BEARINGS

A. General: Under normal loading conditions per NEMA MG1-14.45, bearings shall be 100,000-hour rated unless otherwise specified. Bearings shall be AFBMA Standard sizes.

B. Re-greasable: Bearings shall be re-greasable unless otherwise indicated as sealed-type non-re-greasable.

C. Housing: Bearing housings shall protect against foreign mater entering the bearings and leakage of grease. Housings for re-greasable bearings shall have a capped grease inlet fitting, grease relief plug on the opposite side of the inlet, and a grease reservoir.

D. Extended Lines: Provide extended lubrication lines and fittings to an accessible location for all bearings concealed by equipment housing, belt guards, etc.

E. Factory Lubrication: Bearings shall be provided with grease from the manufacturer. Grease shall be premium moisture resistant containing rust inhibitors and suitable for operation in temperatures from 50 to 250 degrees F.

2.14 FAN, RELIEF AND INTAKE CURB

A. Construction: Prefabricated fan, relief and intake curbs, unless otherwise indicated, shall be constructed of stainless steel with continuous welded seams, 3 inch cant, factory installed treated wood nailer and insulated with 1-1/2 inch thickness 3 pound density rigid fiberglass insulation. Curb height shall be a minimum 12 inches above the finished roof surface unless otherwise indicated or required.

B. Insulated Roofs: Roof curbs on insulated roofs shall have a raised cant the same height as the insulation thickness.

C. Manufacturers:
1. Thycurb, Thybar Corporation
2. Louvers & Dampers, Inc.
3. Pate
4. Or approved equal.

D. Contractor Option: Fan, relief and intake curbs conforming to the above specifications may be provided by the equipment manufacturer.

PART 3 - EXECUTION

3.1 MECHANICAL DEMOLITION

A. Refer to Division 01 Sections "Cutting and Patching" for general demolition requirements and procedures.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Disconnect, demolish, and remove mechanical systems, equipment, and components indicated to be removed.
   1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
   2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
   3. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
   4. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.
   5. Equipment to Be Removed: Disconnect and cap services and remove equipment.
   6. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
   7. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
   8. Label abandoned duct and piping in place as “Abandoned”.

C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 23 Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes, or code minimum.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

J. Install piping to allow application of insulation.

K. Select system components with pressure rating equal to or greater than system operating pressure.

L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
   1. New Piping:
      a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
      b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
      c. Insulated Piping: One-piece, cast-brass type with polished chrome-plated finish.
      d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
      e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece or split-casting, cast-brass type with polished chrome-plated finish.
      f. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with rough-brass finish.
      g. Bare Piping in Equipment Rooms: One-piece, cast-brass type.
      h. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
   2. Existing Piping: Use the following:
      a. Chrome-Plated Piping: Split-casting, cast-brass type with chrome-plated finish.
      b. Insulated Piping: Split-casting, cast-brass type with chrome-plated finish.
      c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.
      d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.
      e. Bare Piping in Unfinished Service Spaces: Split-casting, cast-brass type with polished chrome-plated finish.
      f. Bare Piping in Equipment Rooms: Split-casting, cast-brass type.
      g. Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting, floor-plate type.

M. Sleeves are not required for core-drilled holes.

N. Permanent sleeves are not required for holes formed by removable PE sleeves.

O. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
   1. Cut sleeves to length for mounting flush with both surfaces.
      a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches(50 mm) above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
   2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
   3. Install sleeves that are large enough to provide 1/4-inch(6.4-mm) annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

a. Steel Pipe Sleeves: For pipes smaller than NPS 6(DN 150).
b. Steel Sheet Sleeves: For pipes NPS 6(DN 150) and larger, penetrating gypsum-board partitions.
c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches(50 mm) above finished floor level. Refer to Division 07 for flashing.
1) Seal space outside of sleeve fittings with grout.

4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.

P. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch(25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
1. Install steel pipe for sleeves smaller than 6 inches(150 mm) in diameter.
2. Install cast-iron "wall pipes" for sleeves 6 inches(150 mm) and larger in diameter.
3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

Q. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch(25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

R. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials.

S. Verify final equipment locations for roughing-in.

T. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.3 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
   1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
   2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
   3. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
   4. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
   5. PVC Nonpressure Piping: Join according to ASTM D 2855.
   6. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D 3138 Appendix.

J. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.

K. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.

L. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
   1. Plain-End Pipe and Fittings: Use butt fusion.
   2. Plain-End Pipe and Socket Fittings: Use socket fusion.

M. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3.4 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:
   1. Install unions, in piping NPS 2(DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.
   2. Install flanges, in piping NPS 2-1/2(DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.
   3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
   4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.5 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

E. Locate equipment requiring service in accessible location. Do not reduce service clearances below manufacturer's recommended minimum.

3.6 WORKMANSHIP

A. General: The installation of materials and equipment shall be done in a neat, workmanlike and timely manner by an adequate number of craftsmen knowledgeable of the requirements of the Contract Documents. They shall be skilled in the methods and craftsmanship needed to produce a quality level of workmanship. Personnel who install materials and equipment shall be qualified by training and experience to perform their assigned tasks.

B. Acceptable Workmanship: Acceptable workmanship is characterized by first-quality appearance and function, conforms to applicable standards of building system construction, and exhibiting a degree of quality and proficiency which is judged by the Engineer to be equal or better than that ordinarily produced by qualified industry tradesmen.

C. Material and equipment installations not in compliance with the Contract Documents, or installed with substandard workmanship and not acceptable to the Engineer, shall be removed and reinstalled by qualified craftsmen, at no change in the contract price.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3.7 CORRECTION OF WORK

A. General: At no additional cost to the Owner or Architect/Engineer, rectify discrepancies between the actual installation and contract documents when in the opinion of the T&B Agency or the Architect the discrepancies will affect system balance and performance.

B. Drive Changes: Include the cost of all pulley, belt, and changes, as well as balancing dampers, valves and fittings, and access panels to achieve proper system balance recommended by the T&B Agency.

3.8 COORDINATION AND ASSISTANCE

A. General: Provide all labor, equipment, tools and material required to operate all of the equipment and systems necessary for the testing and balancing of the systems and for the adjustment, calibration or repair of all electric or pneumatic automated control devices and components. These services shall be available on each working day during the period of final testing and balancing.

B. Drawings and Specifications: Provide to the T&B Agency a complete set of drawings and specifications and an approved copy of all HVAC shop drawings. The T&B Agency shall be informed of all changes made to the system during construction, including applicable change orders.

C. Coordination: Coordinate the work of all trades and equipment suppliers to complete the modifications recommended by the T&B Agency and accepted by the Architect. Cut or drill holes for the insertion of air measuring devices as directed for test purposes; repair to as-new condition, inserting plastic caps or covers to prevent air leakage. Repair or replace insulation and re-establish the integrity of the vapor retardant.

3.9 UTILITIES EXCAVATING AND BACKFILLING

A. Perform trenching, excavating, backfilling for mechanical work in accordance with other sections of these specifications and as set forth below.

B. Perform work necessary for installation of mechanical, plumbing utilities.

C. Excavations must be in accordance with OSHA and local requirements.

3.10 CUTTING AND PATCHING

A. Correct damage caused by cutting or installation in performance of contract.

B. Correct damage caused due to installation of mechanical or any division of Contract work.

C. Perform repairs with materials which match existing and install in accordance with the appropriate section of these specifications.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3.11 COUNTERFLASHING

A. Counterflash pipes and any penetrations thru roofs and exterior walls as required to provide a watertight seal. Refer to other sections of the specifications for additional requirements.

3.12 CONNECTION TO EQUIPMENT FURNISHED BY OWNER (OTHERS)

A. Install Owner furnished equipment, fixtures or equipment and fixtures furnished by "others" and make final utility connections shown on the mechanical, plumbing, fire protection and medical gases contract drawings that require such. Field verify exact connection points and installation required.

B. Provide proper rough-ins, piping, valves, unions, strainers, pressure reducing valves, and associated items and connect equipment.

C. Provide piping, shutoff valves, unions, etc., required for a complete installation. In addition, provide steam strainers, steam traps, and line size strainers in steam lines.

D. Operating valves and controls will be provided as an integral part of Owner or "others" furnished equipment.

E. Rough-ins of utilities which conflict with approved shop drawings, or manufacturers cutsheets shall be changed at no expense to the Owner/Architect/Engineer.

3.13 SERVICE OF SYSTEMS

A. If fixtures, products or equipment are placed in service prior to final acceptance of the project by the Owner/Architect/Engineer, operate equipment strictly in accordance with manufacturer's instructions.
   1. Employ competent, qualified personnel in operation of fixtures, products and equipment.
   2. Provide proper operation and cleanliness.
   3. Where water gauges indicate a necessity, install new filters. Clean strainers in systems before turning over to Owner after final acceptance of the project by the Owner/Architect/Engineer.
   4. If Owner/Architect/Engineer directs it, open up fixtures, products or equipment for inspections, close fixtures, products or equipment, and operate equipment in his/their presence for as long as he/they determine it is necessary.

B. Lubricate and service fixtures, products and equipment and perform maintenance as required to place in first class operating condition.

C. Prior to final review and inspection of project by the Owner/Architect/Engineer, clean and polish all fixtures, products, equipment and materials. All required balancing of systems, systems tests, and the placement of all systems in full operating condition shall be completed. If upon the start of the final review and inspection the Owner/Architect/Engineer determine that the above requirements have not been meet, the Owner/Architect/Engineer reserves the right to refuse a final review and inspection at that time, and the total cost of rescheduling the final review and inspection including travel, meals, and any reasonable expenses, shall be paid for in full by the Contractor.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3.14 PAINTING

A. Painting of Division 23 systems, equipment, and components is specified in Division 09 Sections "Interior Painting" and “Exterior Painting”.

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.15 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
   1. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit.
   2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch(450-mm) centers around the full perimeter of the base.
   3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
   4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   5. Install anchor bolts to elevations required for proper attachment to supported equipment.
   6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
   7. Use 3000-psi(20.7-MPa), 28-day compressive-strength concrete and reinforcement.

3.16 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.

B. Field Welding: Comply with AWS D1.1.

3.17 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor mechanical materials and equipment.

B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.

C. Attach to substrates as required to support applied loads.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3.18 GROUTING

A. Mix and install grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

3.19 ACCEPTANCE OF SYSTEMS

A. Complete the following before requesting a final review and inspection.
1. Work required under this division of the specifications except as permitted.
2. Control system checkout.
3. Furnish required operating instructions, wiring diagrams, and pneumatic or electric "project record documents" control diagrams in accordance with Division 01 and mount one copy of each in the equipment rooms as specified elsewhere.
4. Owner/Architect/Engineer shall accept project on the basis of final tests, reports and visual on-site inspection. Furnish the necessary mechanics to operate any and all systems and shall make the required and/or requested necessary adjustments, and shall assist with, and during, the final review and inspection.

B. Certify in writing the following has been completed prior to final inspection:
1. Owning and Operating Manuals have been delivered to Owner's Representative.
2. Any certifications required by individual sections of these specifications have been delivered to Owner's Representative.
3. Record Drawings delivered to Owner's Representative.

C. Provide final test and balance report to Architect two (2) weeks prior to Substantial Completion walk-through.

3.20 WARRANTY AND SERVICE

A. Upon final acceptance of work, Owner will assume responsibility of supervision, operating and maintaining equipment. Owner will report defective materials or workmanship to Contractor. Owner will make emergency repairs only if Contractor is unavailable, and such repairs shall in no case void a warranty or guarantee.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. During the warranty period (one year after date of Certificate of Substantial Completion), Contractor shall replace defective parts, materials and correct defective workmanship without delay.

C. For fixtures, items and equipment or defective workmanship critical to operations, the contractor shall perform warranty work within 24-hours after notice from the Owner. Should the contractor be unable to comply with this time limit, Owner should be made aware of delay and other appropriate arrangements shall be made by the Contractor to maintain necessary operational capability.

D. For fixtures, items and equipment not critical to building operations, warranty work shall be performed as soon as possible, but within five (5) working days. Should availability of repair parts or equipment make the foregoing time limit impractical, the Owner shall be notified of circumstances and expected correction date.

3.21 PROTECTION OF MATERIALS AND EQUIPMENT

A. Requirements: Do not store fiberglass insulation or any equipment within the building until it has been "dried in". If insulation and/or equipment must be installed before the building is "dried in" and completely enclosed, provide protection as recommended by the manufacturer.

B. Replacement of Damaged Stored Material and/or Equipment: Any material and/or equipment that has been wet or otherwise damaged prior to installation, in the opinion of the Architect, shall be replaced with new material regardless of the condition of the material and/or equipment at the time of installation.

C. Repair of Damaged Installed Material and/or Equipment: After installation correct or repair dents, scratches and other visible blemishes. At the direction of Architect replace or repair to "as new" condition equipment which has been damaged during construction.

3.22 ASBESTOS AND HAZARDOUS MATERIALS

A. General: Should asbestos or other hazardous material be encountered during execution of the work, or should the presence of asbestos or other hazardous material be suspected, immediately notify the Architect and suspend work in the affected area. The Owner will initiate a study to determine if asbestos or other hazardous materials are present and will determine what action will be taken. Removal of asbestos or other hazardous materials will be done under a separate contract.

3.23 COORDINATION OF SERVICES

A. General: Interruption of existing services shall be coordinated in writing at least 1 week in advance with the Architect. Shutdown time and duration of services interruption shall be decided by the Owner. Provide shutoff valves at points of interconnection to minimize downtime. Procedures incidental to the outage shall be prepared in advance to minimize downtime.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Fire Safety in Existing facilities: Do not decrease the fire rating of walls, partitions, ceilings, floors, doors or combinations thereof in adjacent areas or means of egress. Do not interrupt fire sprinkling or life safety systems without prior coordination with the Architect. Inform all necessary parties (Fire Department, Owner's insurance carrier, etc.) in advance, prior to and immediately after shutdown, disconnection or isolation of any portion of life safety or fire sprinkler system.

C. Protection of Facilities: Portions of the building may be operational during construction. Maintain operation of the equipment and systems whenever the installation interfaces with existing equipment or systems. Provide protection for the building, its contents and occupants wherever installation under the contract is performed. As necessary, move, store, and protect furniture, office fixtures and carpets. Provide acoustical isolation of the work area via temporary doors, partitions, etc., to allow normal work functions. Provide exhaust fans, temporary dust barrier partitions and any containment measures required to prevent dirt, dust or fumes from reaching adjacent occupied spaces as required by the Owner or Architect. Access to the building, including exit stairs, doors and passageways, and loading dock and other delivery areas shall be kept open and continuously accessible to the occupants. Workmen shall be confined to those areas directly involved in the project installation, and only during time periods indicated and approved by the Owner.

3.24 LAYOUT OF EXISTING EQUIPMENT AND SYSTEMS

A. General: Existing equipment, piping, ductwork, etc., as indicated on the drawings have, for the most part, been provided to the Architect through existing drawings. The layouts shown may not be from as-built drawings and may be from partial copies of original design documents not produced by the Architect. The Architect is not responsible for the accuracy nor completeness of the existing installation and all layouts are shown for reference only. It is to be understood that unforseen conditions may exist and that existing and new work may not be field located exactly as shown on the drawings. Verify existing conditions in the field and notify the Architect of any deviations required to install the work as shown. Coordinate new work with existing equipment, including removing, relocating, rerouting, extending with new materials, and reinstall existing piping, ductwork, conduits, wiring, tubing, supports and other equipment. The Architect shall make the final decision on all deviations or modifications required by the existing conditions.

3.25 OWNERSHIP OF REMOVED EQUIPMENT AND MATERIALS

A. General: Construction materials and items of mechanical and electrical equipment which are removed and not reused shall be removed from the jobsite unless indicated as to be retained for the Owner. The rigging, removal and hauling cost, as well as any salvage value, shall be included in the contract.

3.26 CLEAN-UP

A. General: Debris and rubbish shall not be disposed of in the Owner's containers.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3.27 MECHANICAL EQUIPMENT CLEANING

A. Remove, or repair, dents, scratches, and/or foreign materials (paint, drywall compound, etc.) from mechanical equipment and touch-up damaged finishes using matching paint provided by unit manufacturer. Surfaces to be painted shall be cleaned of dirt and moisture before painting. Repair damaged fins on coils by combing out fins prior to putting system in operation.

B. Remove construction debris from mechanical equipment rooms before start-up of equipment located within those rooms. Air handling unit casings, fan coil cabinets, etc., shall be vacuumed prior to start-up to remove dust and debris accumulated during storage and/or construction.

C. Air conditioning units, air handling units, etc., shall not be operated without filters.

D. Protect fan inlets and outlets, and heating/cooling coils, during construction by covering these openings.

3.28 MECHANICAL DUCTWORK CLEANING

A. Protection and cleaning during construction:
   1. Dust, dirt and other foreign matter which accumulates on air side surfaces during construction shall be removed as construction proceeds and not allowed to accumulate. Affected air side surfaces shall be cleaned or washed as required to maintain a clean condition.
   2. Unfinished openings in ductwork and equipment shall be closed when construction activities are not in progress on them. Any method of closing unfinished openings which maintains the cleanliness of the air side surfaces is acceptable.
   3. All air side surfaces which become soiled due to failure to adequately protect unfinished openings shall be cleaned prior to proceeding with additional work on the affected materials and equipment. If cleaning or washing cannot return the affected materials and equipment to their original clean condition, they shall be replaced.

B. Water Damage:
   1. Air side surfaces shall be protected from the entry of water at all times except when washing procedures are being employed or when surfaces are wetted during the normal operation of equipment.
   2. Hard surfaces which become wet shall be dried out and wiped down. Any visible residue remaining shall be removed by washing the affected area. If washing does not remove the residue, the materials and equipment affected shall be replaced.
   3. Lining materials which become wet shall be thoroughly dried using warm air not to exceed 105^0F. If lining materials cannot be substantially dried within 24 hours of their wetting, or if drying and cleaning does not remove all residues, the affected materials shall be removed and replaced.

C. Clean surfaces of all air distribution diffusers, grilles, registers, etc. Where finish is irregular or damaged, finish shall be touched-up with paint supplied by manufacturer.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3.29 MECHANICAL PIPING SYSTEM CLEANING

A. Refrigerant piping systems shall be cleaned in accordance with methods described in Division 23 "Refrigerant Piping".

3.30 V-BELT DRIVE

A. Sheaves: To provide the properly sized sheave, V-belt drive fans shall be initially provided with variable pitch sheaves. Upon completion of system balancing by the T&B Agency, the adjustable pitch sheaves shall be replaced with fixed sheaves and belts of the size and type specified by the T&B Agency. Tag the adjustable sheaves, turn over to the Owner, and receive written receipt from the Owner accepting these sheaves.

B. Vibration of Air Handling Equipment and Fan Units: Field vibration levels will not be acceptable for air handling equipment and fans driven by motors 5 hp or greater, if the maximum vibration velocity or displacement measurement exceeds the following values (when measurements are taken at the bearing supports using a vibration analyzer with the filter set at the operating fan speed):

3.31 EQUIPMENT CURB AND MOUNTING RAILS

A. Structural Support: Each equipment curb or mounting rail shall be fully supported by the roof structure. Changes in roof mounted equipment may require a change in the structural support. Any discrepancies shall be reported to the Architect prior to the purchase and installation of the equipment curb or mounting rails.

B. Installation: Follow the manufacturer's recommendations for installation. The top of each curb shall be level, with the pitch built into the curb where roof slopes 1/4 of an inch per foot or more. The installation and flashing of the roof curbs shall comply with the manufacturers requirements. Provide a watertight counter flashing for each curb or mounting support.

3.32 FAN, RELIEF AND INTAKE CURB

A. General: The top of each curb shall be level, with the pitch built into the curb where roof slopes 1/4 of an inch per foot or more. Exterior curb dimensions shall be coordinated with the counterflashing of the installed equipment.

B. Installation: The installation and flashing of the roof curbs shall comply with the manufacturers requirements and the roofing system warranty requirements.

3.33 HOUSEKEEPING PADS AND EQUIPMENT SUPPORTS

A. Housekeeping Pads: Provide reinforced concrete housekeeping pads where indicated and for all floor mounted equipment located in rooms where water piping exist. Pads shall be 4 inches high unless otherwise indicated. Unless otherwise indicated ground mounted equipment shall have an 8 inch high reinforced concrete housekeeping pad. The pad shall extend a minimum of 6 inches above finish grade.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Equipment Bases: Equipment bases shall be 4 inches high unless otherwise indicated or required. Bases for air handling equipment shall be high enough to provide the required trap seal and insulation for the condensate drain.

C. Isolated Concrete Bases: Unless otherwise indicated isolated concrete bases shall be a minimum of 6 inches and shall weigh at least 2-1/2 times the weight of the rotating assembly.

D. Inertia Bases: Inertia bases shall be installed according to the requirements stated in Division 15 "Mechanical Vibration and Seismic Controls".

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following hangers and supports for HVAC system piping and equipment:
   1. Steel pipe hangers and supports.
   2. Trapeze pipe hangers.
   3. Fiberglass pipe hangers.
   4. Metal framing systems.
   5. Fiberglass strut systems.
   6. Thermal-hanger shield inserts.
   7. Fastener systems.
   8. Pipe stands.
   9. Equipment supports.

B. Related Sections include the following:
   1. Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" for vibration isolation devices.
   2. Division 23 Section "Metal Ducts" for duct hangers and supports.

1.3 DEFINITIONS

A. MSS: Manufacturers Standardization Society for The Valve and Fittings Industry Inc.

B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.4 PERFORMANCE REQUIREMENTS

A. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

C. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

1.5 SUBMITTALS

A. Product Data: For the following:
   1. Steel pipe hangers and supports.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2. Fiberglass pipe hangers.
3. Thermal-hanger shield inserts.
4. Powder-actuated fastener systems.

1.6 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to the following:
   1. AWS D1.1, "Structural Welding Code--Steel."
   2. AWS D1.2, "Structural Welding Code--Aluminum."
   3. AWS D1.3, "Structural Welding Code--Sheet Steel."
   4. AWS D1.4, "Structural Welding Code--Reinforcing Steel."
   5. ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 STEEL PIPE HANGERS AND SUPPORTS

A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.

B. Acceptable Manufacturers:
   1. AAA Technology & Specialties Co., Inc.
   2. Bergen-Power Pipe Supports.
   3. B-Line Systems, Inc.; a division of Cooper Industries.
   4. Carpenter & Paterson, Inc.
   5. Empire Industries, Inc.
   6. ERICO/Michigan Hanger Co.
   7. Globe Pipe Hanger Products, Inc.
   8. Grinnell Corp.
   9. GS Metals Corp.
   10. National Pipe Hanger Corporation.
   11. PHD Manufacturing, Inc.
   12. PHS Industries, Inc.
   13. Piping Technology & Products, Inc.
   14. Tolco Inc.
   15. Or approved equal.

C. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.3 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

2.4 FIBERGLASS PIPE HANGERS

A. Clevis-Type, Fiberglass Pipe Hangers: Similar to MSS Type 1, steel pipe hanger except hanger is made of fiberglass and continuous-thread rod and nuts are made of stainless steel.
   1. Acceptable Manufacturers:
      a. B-Line Systems, Inc.; a division of Cooper Industries.
      b. Champion Fiberglass, Inc.
      c. Cope, T. J., Inc.; Tyco International, Ltd.
      d. Seasafe, Inc.
      e. Unistrut Corp.; Tyco International, Ltd.
      f. Wesanco, Inc.
      g. Or approved equal.

B. Strap-Type, Fiberglass Pipe Hangers: Made of fiberglass loop with stainless-steel continuous-thread rod, nuts, and support hook.
   1. Acceptable Manufacturers:
      a. Plasti-Fab, Inc.
      b. Or approved equal.

2.5 METAL FRAMING SYSTEMS

A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.

B. Acceptable Manufacturers:
   1. B-Line Systems, Inc.; a division of Cooper Industries.
   2. ERICO/Michigan Hanger Co.; ERISTRUT Div.
   3. GS Metals Corp.
   4. Power-Strut Div.; Tyco International, Ltd.
   5. Thomas & Betts Corporation.
   6. Tolco Inc.
   7. Unistrut Corp.; Tyco International, Ltd.
   8. Or approved equal.

C. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2.6 FIBERGLASS STRUT SYSTEMS

A. Description: Shop- or field-fabricated pipe-support assembly, similar to MFMA-3, made of fiberglass channels and other components.

B. Acceptable Manufacturers:
1. B-Line Systems, Inc.; a division of Cooper Industries.
2. Champion Fiberglass, Inc.
3. Cope, T. J., Inc.; Tyco International Ltd.
4. Seasafe, Inc.
5. Or approved equal.

2.7 THERMAL-HANGER SHIELD INSERTS

A. Description: 100-psig- (690-kPa-) minimum, compressive-strength insulation insert encased in sheet metal shield.

B. Acceptable Manufacturers:
1. Carpenter & Paterson, Inc.
2. ERICO/Michigan Hanger Co.
3. PHS Industries, Inc.
4. Pipe Shields, Inc.
5. Rilco Manufacturing Company, Inc.
6. Value Engineered Products, Inc.
7. Or approved equal.

C. Insulation-Insert Material for Cold Piping: Type II cellular glass with vapor barrier.

D. Insulation-Insert Material for Hot Piping: ASTM C 552, Type II cellular glass.

E. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

F. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

G. Insert Length: Extend 2 inches (50 mm) beyond sheet metal shield for piping operating below ambient air temperature.

2.8 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
1. Acceptable Manufacturers:
   a. Hilti, Inc.
   b. ITW Ramset/Red Head.
   c. Masterset Fastening Systems, Inc.
   d. MKT Fastening, LLC.
   e. Powers Fasteners.
   f. Or approved equal.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Mechanical-Expansion Anchors: Insert-wedge-type stainless steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
   1. Acceptable Manufacturers:
      a. B-Line Systems, Inc.; a division of Cooper Industries.
      b. Empire Industries, Inc.
      c. Hilti, Inc.
      d. ITW Ramset/Red Head.
      e. MKT Fastening, LLC.
      f. Powers Fasteners.
      g. Or approved equal.

2.9 PIPE STAND FABRICATION

A. Pipe Stands, General: Shop or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

B. Compact Pipe Stand: One-piece plastic unit with integral-rod-roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
   1. Acceptable Manufacturers:
      a. ERICO/Michigan Hanger Co.
      b. MIRO Industries.
      c. Or approved equal.

C. Low-Type, Single-Pipe Stand: One-piece stainless-steel base unit with plastic roller, for roof installation without membrane penetration.
   1. Acceptable Manufacturers:
      a. MIRO Industries.
      b. Or approved equal.

D. High-Type, Single-Pipe Stand: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
   1. Acceptable Manufacturers:
      a. ERICO/Michigan Hanger Co.
      b. MIRO Industries.
      c. Portable Pipe Hangers.
      d. Or approved equal.
   2. Base: Stainless steel.
   3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
   4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.

E. High-Type, Multiple-Pipe Stand: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
   1. Acceptable Manufacturers:
      a. Portable Pipe Hangers.
      b. Or approved equal.
   2. Bases: One or more plastic.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3. Vertical Members: Two or more protective-coated-steel channels.
4. Horizontal Member: Protective-coated-steel channel.
5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.

F. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe support made from structural-steel shape, continuous-thread rods, and rollers for mounting on permanent stationary roof curb.

2.10 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.

2.11 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use padded hangers for piping that is subject to scratching.

F. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30 (DN 15 to DN 750).
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F (49 to 232 deg C) pipes, NPS 4 to NPS 16 (DN 100 to DN 400), requiring up to 4 inches (100 mm) of insulation.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24 (DN 20 to DN 600), requiring clamp flexibility and up to 4 inches (100 mm) of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24 (DN 15 to DN 600), if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4 (DN 15 to DN 100), to allow off-center closure for hanger installation before pipe erection.
6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated stationary pipes, NPS 3/4 to NPS 8 (DN 20 to DN 200).
7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8 (DN 15 to DN 200).
8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8 (DN 15 to DN 200).
9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 2 (DN 15 to DN 50).
10. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 8 (DN 10 to DN 200).
11. Extension Hinged or 2-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 3 (DN 10 to DN 80).
12. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30 (DN 15 to DN 750).
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36 (DN 100 to DN 900), with steel pipe base stanchion support and cast-iron floor flange.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36 (DN 100 to DN 900), with steel pipe base stanchion support and cast-iron floor flange and with U-bolt to retain pipe.
16. Adjustable, Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes, NPS 2-1/2 to NPS 36 (DN 65 to DN 900), if vertical adjustment is required, with steel pipe base stanchion support and cast-iron floor flange.
17. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30 (DN 25 to DN 750), from 2 rods if longitudinal movement caused by expansion and contraction might occur.
18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20 (DN 65 to DN 500), from single rod if horizontal movement caused by expansion and contraction might occur.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42 (DN 50 to DN 1050), if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes, NPS 2 to NPS 24 (DN 50 to DN 600), if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes, NPS 2 to NPS 30 (DN 50 to DN 750), if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20 (DN 20 to DN 500).
   2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20 (DN 20 to DN 500), if longer ends are required for riser clamps.

H. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches (150 mm) for heavy loads.
   2. Steel Clevises (MSS Type 14): For 120 to 450 deg F (49 to 232 deg C) piping installations.
   3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
   4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
   5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F (49 to 232 deg C) piping installations.

I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
   2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.
   3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
   4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
   5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
   6. C-Clamps (MSS Type 23): For structural shapes.
   7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
   8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
   9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
   10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
   11. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
   12. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:
      a. Light (MSS Type 31): 750 lb (340 kg).
      b. Medium (MSS Type 32): 1500 lb (680 kg).
      c. Heavy (MSS Type 33): 3000 lb (1360 kg).
   13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

J. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

K. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches (32 mm).
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
    a. Horizontal (MSS Type 54): Mounted horizontally.
    b. Vertical (MSS Type 55): Mounted vertically.
    c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

L. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.

M. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.

N. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3.2 HANGER AND SUPPORT INSTALLATION

A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.
   1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
   2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.

C. Fiberglass Pipe Hanger Installation: Comply with applicable portions of MSS SP-69 and MSS SP-89. Install hangers and attachments as required to properly support piping from building structure.

D. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.

E. Fiberglass Strut System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled fiberglass struts.

F. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

G. Fastener System Installation:
   1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches (100 mm) thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
   2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

H. Pipe Stand Installation:
   1. Pipe Stand Types except Curb-Mounting Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
   2. Curb-Mounting-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. Refer to Division 07 Section "Roof Accessories" for curbs.

I. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.

J. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

K. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

L. Install lateral bracing with pipe hangers and supports to prevent swaying.

M. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 (DN 65) and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

N. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

O. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.1 (for power piping) and ASME B31.9 (for building services piping) are not exceeded.

P. Insulated Piping: Comply with the following:
   1. Attach clamps and spacers to piping.
      a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
      b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
      c. Do not exceed pipe stress limits according to ASME B31.1 for power piping and ASME B31.9 for building services piping.
   2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
      a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.
   3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
      a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.
   4. Shield Dimensions for Pipe: Not less than the following:
      a. NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.
      b. NPS 4 (DN 100): 12 inches (305 mm) long and 0.06 inch (1.52 mm) thick.
      c. NPS 5 and NPS 6 (DN 125 and DN 150): 18 inches (457 mm) long and 0.06 inch (1.52 mm) thick.
      d. NPS 8 to NPS 14 (DN 200 to DN 350): 24 inches (610 mm) long and 0.075 inch (1.91 mm) thick.
      e. NPS 16 to NPS 24 (DN 400 to DN 600): 24 inches (610 mm) long and 0.105 inch (2.67 mm) thick.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

5. Pipes NPS 8 (DN 200) and Larger: Include wood inserts.
6. Insert Material: Length at least as long as protective shield.
7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make smooth bearing surface.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:
1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches (40 mm).

3.6 PAINTING

A. Touch Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting Sections.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
1. Elastomeric isolation pads and mounts.
2. Restrained elastomeric isolation mounts.
3. Freestanding and restrained spring isolators.
4. Elastomeric hangers.
5. Spring hangers.
6. Spring hangers with vertical-limit stops.
7. Thrust limits.
8. Pipe riser resilient supports.
9. Resilient pipe guides.
10. Restrained vibration isolation roof-curb rails.
11. Seismic snubbers.
12. Restraining cables.
13. Steel and inertia, vibration isolation equipment bases.

1.3 DEFINITIONS

A. A_v: Effective peak velocity related acceleration coefficient.

B. S_{D1}: 1 second period, five percent damped design spectral response acceleration.

1.4 PERFORMANCE REQUIREMENTS

A. S_{D1}: Refer to "Seismic Requirements" specification.

B. Component Seismic Coefficient: Refer to schedule at end of section.

C. Performance Criteria Factor: Refer to schedule at end of section.

D. Attachment Amplification Factor: Refer to schedule at end of section.

E. Wind-Restraint Loading:
1. Basic Wind Speed: 90 mph.
2. Building Classification Category: III.
3. Minimum 10 lb/sq. ft. (48.8 kg/sq. m) multiplied by the maximum area of the HVAC component projected on a vertical plane that is normal to the wind direction, and 45 degrees either side of normal.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1.5 SUBMITTALS

A. Product Data: Include load deflection curves for each vibration isolation device.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Include the following:
   1. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
   2. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system has been examined for excessive stress and that none will exist.
   3. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment, and cantilever loads.
   4. Seismic-Restraint Details: Detail fabrication and attachment of seismic restraints and snubbers. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors.
   5. Submittals for Interlocking Snubbers: Include load deflection curves up to 1/2-inch(13-mm) deflection in x, y, and z planes.

C. Welding certificates.

D. Manufacturer Seismic Qualification Certification: Submit certification that all specified equipment will withstand seismic forces identified in "Performance Requirements" Article above. Include the following:
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.
      a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.6 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel."

B. Component and Attachment Testing: The component manufacturer shall test or analyze the component and the component mounting system or anchorage for the design forces in Chapter 16 for those components having a Component Importance Factor of 1.0 or 1.5 in accordance with Chapter 16. The manufacturer shall submit a certificate of compliance for review and acceptance by the registered design professional responsible for the design, and for approval by the building official. The basis of certification shall

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

be by test on a shaking table, by three-dimensional shock tests, by an analytical method using dynamic characteristics and forces from Chapter 16 or by more rigorous analysis.

C. Component Manufacturer Certification: Each manufacturer of equipment to be placed in a building assigned to Seismic Design Categories E and F, in accordance with Chapter 16, where the equipment has a Component Importance Factor of 1.0 or 1.5 in accordance with Chapter 16, shall maintain an approved quality control program. Evidence of the quality control program shall be permanently identified on each piece of equipment by a label.

1.7 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into base. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 VIBRATION ISOLATORS

A. Manufacturers:
   1. Amber/Booth Company, Inc.
   2. B-Line Systems, Inc.
   3. Isolation Technology, Inc.
   4. Kinetics Noise Control, Inc.
   5. Mason Industries, Inc.
   6. Vibration Eliminator Co., Inc.
   7. Vibration Isolation Co., Inc.
   8. Vibration Mountings & Controls/Korfund.
   9. Or approved equal.

B. Elastomeric Isolator Pads (Type 1): Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers, molded with a nonslip pattern and galvanized steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.
   1. Material: Standard neoprene.
   2. Durometer Rating: 50.
   3. Number of Layers: Provide additional layers separated by steel shims, wherever deflection exceeds 0.15 inch at 60 psi loading.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

C. Elastomeric Mounts (Type 2): Double-deflection type, with molded, oil-resistant rubber or neoprene isolator elements with factory-drilled, encapsulated top plate for bolting to equipment and with baseplate for bolting to structure. Color-code or otherwise identify to indicate capacity range.
   1. Durometer Rating: 50.

D. Restrained Elastomeric Mounts (Type 2): All-directional elastomeric mountings with seismic restraint.
   1. Materials: Cast-ductile-iron housing containing two separate and opposing, molded, bridge-bearing neoprene elements that prevent central threaded sleeve and attachment bolt from contacting the casting during normal operation.
   2. Neoprene: Shock-absorbing materials compounded according to AASHTO M251, the standard for bridge-bearing neoprene.

E. Spring Isolators (Type 3): Freestanding, laterally stable, open-spring isolators.
   1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
   2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
   3. Lateral Stiffness: More than 80 percent of the rated vertical stiffness.
   4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
   5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch-(6-mm-) thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 100 psig(690 kPa).
   6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

F. Restrained Spring Isolators (Type 4): Freestanding, steel, open-spring isolators with seismic restraint.
   1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 1/4-inch-(6-mm-) thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
   2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
   3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
   4. Lateral Stiffness: More than 80 percent of the rated vertical stiffness.
   5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

G. Elastomeric Hangers (Type 2A): Double-deflection type, with molded, oil-resistant rubber or neoprene isolator elements bonded to steel housings with threaded connec-tions for hanger rods. Color-code or otherwise identify to indicate capacity range.

H. Spring Hangers (Type 3A): Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of the rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.

I. Spring Hangers with Vertical-Limit Stop (Type 3B): Combination coil-spring and elastomeric-insert hanger with spring and insert in compression and with a vertical-limit stop.
1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of the rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
7. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.

J. Thrust Limits (Type 5): Combination coil spring and elastomeric insert with spring and insert in compression and with a load stop. Include rod and angle-iron brackets for attaching to equipment.
1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of the rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch(6-mm) movement at start and stop.

K. Pipe Riser Resilient Support: All-directional, acoustical pipe anchor consisting of 2 steel tubes separated by a minimum of 1/2-inch-(13-mm-) thick, 60-durometer neoprene. Include steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions. Design support for a maximum load on the isolation material of 500 psig(3.45 MPa) and for equal resistance in all directions.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

L. Resilient Pipe Guides: Telescopic arrangement of 2 steel tubes separated by a minimum of 1/2-inch-(13-mm-) thick, 60-durometer neoprene. Factory set guide height with a shear pin to allow vertical motion due to pipe expansion and contraction. Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2.3 SEISMIC-RESTRAINT DEVICES

A. Manufacturers:
1. Amber/Booth Company, Inc.
2. B-Line Systems, Inc.
3. Kinetics Noise Control, Inc.
4. Mason Industries, Inc.
5. Unistrut Diversified Products Co.; Wayne Manufacturing Division.
6. Vibration Eliminator Co., Inc.
7. Vibration Isolation Co., Inc.
8. Vibration Mountings & Controls/Korfund.
9. Or approved equal.

B. Resilient Isolation Washers and Bushings: 1-piece, molded, bridge-bearing neoprene complying with AASHTO M 251 and having a durometer of 50, plus or minus 5, with a flat washer face.

C. Seismic Snubbers: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.
1. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
2. Resilient Isolation Washers and Bushings: 1-piece, molded, bridge-bearing neoprene complying with AASHTO M 251 and having a durometer of 50, plus or minus 5.

D. Restraining Cables: Galvanized steel aircraft cables with end connections made of steel assemblies that swivel to final installation angle and utilize two clamping bolts for cable engagement.

E. Anchor Bolts: Seismic-rated, drill-in, and stud-wedge or female-wedge type. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488/E 488M.

2.4 VIBRATION ISOLATION EQUIPMENT BASES

A. Manufacturers:
1. Amber/Booth Company, Inc.
2. Isolation Technology, Inc.
3. Kinetics Noise Control, Inc.
4. Mason Industries, Inc.
5. Vibration Eliminator Co., Inc.
6. Vibration Isolation Co., Inc.
7. Vibration Mountings & Controls/Korfund.
8. Or approved equal.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Direct attachment, no base (Type A).
   1. Design Requirements: Condition

C. Steel Base (Type B): Factory-fabricated, welded, structural-steel bases and rails.
   1. Design Requirements: Lowest possible mounting height with not less than 1-inch(25-mm) clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails. Include supports for suction and discharge elbows for pumps.
   2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/ A 36M. Bases shall have shape to accommodate supported equipment.
   3. Support Brackets: Factory-welded steel angles on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

D. Inertia Base (Type C): Factory-fabricated, welded, structural-steel bases and rails ready for field-applied, cast-in-place concrete.
   1. Design Requirements: Lowest possible mounting height with not less than 1-inch(25-mm) clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails. Include supports for suction and discharge elbows for pumps.
   2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/ A 36M. Bases shall have shape to accommodate supported equipment.
   3. Support Brackets: Factory-welded steel angles on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
   4. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

E. Restrained Vibration Isolation Roof-Curb Rails (Type D Base):
   1. Description: Factory-assembled, fully enclosed, insulated, air- and watertight curb rail designed to resiliently support equipment and to withstand 125-mph(56-m/s) wind impinging laterally against side of equipment.
   2. Lower Support Assembly: Sheet-metal "Z" section containing adjustable and removable steel springs that support upper floating frame. Upper frame shall provide continuous support for equipment and shall be captive to resiliently resist wind and seismic forces. Lower support assembly shall have a means for attaching to building structure and a wood nailer for attaching roof materials, and shall be insulated with a minimum of 2 inches(50 mm) of rigid, glass-fiber insulation on inside of assembly.
   3. Spring Isolators: Adjustable, restrained spring isolators shall be mounted on 1/4-inch-(6-mm-) thick, elastomeric vibration isolation pads and shall have access ports, for level adjustment, with removable waterproof covers at all isolator locations. Isolators shall be located so they are accessible for adjustment at any time during the life of the installation without interfering with the integrity of the roof.
      a. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic restraint.
         1) Housing: Steel with resilient vertical-limit stops and adjustable equipment mounting and leveling bolt.
         2) Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
         3) Minimum Additional Travel: 50 percent of the required deflection at rated load.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

4) Lateral Stiffness: More than 80 percent of the rated vertical stiffness.
5) Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

b. Elastomeric Isolator Pads: Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers, molded with a nonslip pattern and galvanized steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.
1) Material: Standard neoprene.
2) Durometer Rating: 50.
3) Number of Layers: Provide additional layers separated by steel shims, whenever deflection exceeds 0.15 inch at 60 psi loading.

4. Snubber Bushings: All-directional, elastomeric snubber bushings at least 1/4 inch(6 mm) thick.
5. Water Seal: Galvanized sheet metal with EPDM seals at corners, attached to upper support frame, extending down past wood nailer of lower support assembly, and counterflashed over roof materials.

2.5 FACTORY FINISHES

A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.
1. Powder coating on springs and housings.
2. All hardware shall be electrogalvanized. Hot-dip galvanize metal components for exterior use.
3. Baked enamel for metal components on isolators for interior use.
4. Color-code or otherwise mark vibration isolation and seismic-control devices to indicate capacity range.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and seismic-control devices for compliance with requirements, installation tolerances, and other conditions affecting performance.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSPECTION

A. Special inspection shall be required per the specification section "Special Inspection" for vibration and seismic controls, for buildings classified as Seismic Design Categories C, D, E, or F.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3.3 INSTALLATION

A. Install roof curbs, equipment supports, and roof penetrations as specified in Division 07 Section "Roof Accessories."

B. Install thrust limits at centerline of thrust, symmetrical on either side of equipment.

C. Install seismic snubbers on isolated equipment. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.

D. Install restraining cables at each trapeze and individual pipe hanger. At trapeze anchor locations, shackle piping to trapeze. Install cables so they do not bend across sharp edges of adjacent equipment or building structure.

E. Install steel angles or channel, sized to prevent buckling, clamped with ductile-iron clamps to hanger rods for trapeze and individual pipe hangers. At trapeze anchor locations, shackle piping to trapeze. Requirements apply equally to hanging equipment. Do not weld angles to rods.

F. Install resilient bolt isolation washers on equipment anchor bolts.

3.4 EQUIPMENT BASES

A. Fill concrete inertia bases, after installing base frame, with 3000-psi(20.7-MPa) concrete; trowel to a smooth finish.
   1. Cast-in-place concrete materials and placement requirements are specified in Division 03.

B. Concrete Bases: Anchor equipment to concrete base according to supported equipment manufacturer's written instructions for seismic codes at Project site.
   1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch(450-mm) centers around the full perimeter of the base.
   2. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base and anchor into structural concrete floor.
   3. Place and secure anchorage devices. Use Setting Drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   4. Install anchor bolts to elevations required for proper attachment to supported equipment.
   5. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
   6. Cast-in-place concrete materials and placement requirements are specified in Division 03.

3.5 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality-control testing:
   1. Isolator seismic-restraint clearance.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2. Isolator deflection.
3. Snubber minimum clearances.

3.6 ADJUSTING

A. Adjust isolators after piping systems have been filled and equipment is at operating weight.

B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

C. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch(6-mm) movement during start and stop.

D. Adjust active height of spring isolators.

E. Adjust snubbers according to manufacturer's written recommendations.

F. Adjust seismic restraints to permit free movement of equipment within normal mode of operation.

G. Torque anchor bolts according to equipment manufacturer's written recommendations to resist seismic forces.

3.7 CLEANING

A. After completing equipment installation, inspect vibration isolation and seismic-control devices. Remove paint splatters and other spots, dirt, and debris.

3.8 VIBRATION ISOLATOR SEISMIC-RESTRAINT SCHEDULE

MECHANICAL AND ELECTRICAL COMPONENTS COEFFICIENTS

Mechanical and Electrical Component or Element	a_P	R_P
1. General Mechanical		
a. Boilers and furnaces	1.0	2.5
b. Pressure vessels on skirts and free-standing	2.5	2.5
c. Stacks	2.5	2.5
d. Cantilevered chimneys	2.5	2.5
e. Other	1.0	2.5
2. Manufacturing and Process Machinery		
a. General	1.0	2.5
b. Conveyors (non-personnel)	2.5	2.5
3. HVAC System Equipment		
a. Vibration isolated	2.5	2.5
b. Non-vibration isolated	1.0	2.5
c. Mounted in-line with ductwork	1.0	2.5

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

MECHANICAL AND ELECTRICAL COMPONENTS COEFFICIENTS

	Mechanical and Electrical Component or Element	a_P	R_P
d.	Other	1.0	2.5

Notes:

a_P: Component amplification factor

R_P: Component response modification factor

COMPONENT IMPORTANCE FACTOR

The component importance factor, I_P, shall be as follows:

I_P = 1.5 Life-safety component is required to function after an earthquake.

I_P = 1.5 Component contains hazardous or flammable material in quantities that exceed the exempted amounts for an open system listed in Chapter 4.

I_P = 1.5 Storage racks in occupancies open to the general public (e.g., warehouse retail stores).

I_P = 1.0 All other components.

In addition, for structures in Seismic Use Group III:

I_P = 1.5 Components needed for continued operation of the facility or whose failure could impair the continued operation of the facility.

3.9 VIBRATION ISOLATION SCHEDULE

Equipment	Base Type	Isolator Type	Deflection
Refrigeration Machines			
Reciprocating/Screw Chillers, On Grade	A	2	0.25"
Centrifugal or Screw Chillers, On Grade	A	2	0.25"
Absorption Chillers, On Grade	A	1	0.25
Reciprocating/Screw Chillers on Concrete Structure	A	4	2.50"
Centrifugal Chillers on Concrete Structure	A	4	1.50"
Absorption Chillers on Concrete Structure	A	4	1.50"
Reciprocating/Screw Chillers on Steel Structure	C	4	2.50"
Centrifugal Chillers on Steel Structure	C	4	1.50"
Absorption Chillers on Steel Structure	A	4	1.50"
Air-Cooled Reciprocating/Screw Chiller on Pad	A	2	0.25"
Air-Cooled Reciprocating/Screw Chillers on Roof	B	4	2.50"
Air Compressors/Vacuum Pumps			
Tank Mounted Horizontal, Up to 10 HP on Grade	A	3	0.75"
Tank Mounted Horizontal, Over 10 HP; Vertical; or Base Mounted, On Grade	C	3	0.75"
Tank Mounted Horizontal, Up to 10 HP on Concrete Structure	A	3	0.75"
Tank Mounted Horizontal, Over 10 HP; Vertical; or Base Mounted, On Concrete Structure	C	3	0.75"
Tank Mounted Horizontal, Up to 10 HP on Steel Structure	A	3	1.50"

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

Equipment	Base Type	Isolator Type	Deflection
Tank Mounted Horizontal, Over 10 HP; Vertical; or Base Mounted, on Steel Structure	C	3	1.50"
Pumps			
Base Mounted End Suction, on Concrete Structure	C	3	0.75"
Split Case, on Concrete Structure	C	3	0.75"
Base Mounted End Suction, on Steel Structure	C	3	1.50"
Split Case, Slab on Grade, on Steel Structure	C	3	1.50"
In-Line (5 HP and Over)	A	3A	1.50"
Cooling Towers			
Cooling Towers on Grade	A	1	0.25"
Cooling Towers on Concrete Structure	A	4	1.50"
Cooling Towers on Steel Structure	A	4	3.50"
Boilers			
Firetube, on Grade	A	None	N.A.
Firetube, on Concrete Structure	A	1	0.25"
Firetube, on Steel Structure	A	4	0.75"
Air Handling Units			
Air Handling Units, on Grade	A	3	0.75"
Air Handling Units, on Concrete Structure	A	3	1.50"
Air Handling Units, on Steel Structure	C	3	2.50"
Fans			
In-Line Centrifugal or Axial	A	3B	0.75"
Centrifugal Fan 10 HP and Larger, on Grade	A	2	0.25"
Centrifugal Fan 10 HP and Larger, on Concrete Structure	A	3	0.75"
Centrifugal Fan 10 HP and Larger, on Steel Structure	C	3	1.50"
Unitary Equipment			
Condensing Unit or Heat Pump, on Grade	A	2	0.25"
Condensing Unit or Heat Pump, 15 Tons and Under, Roof Mounted	B	2	0.25"
Condensing Unit or Heat Pump, Over 15 Tons, Roof Mounted	B or D	3	1.50"
Packaged Water-Cooled Indoor Air Conditioning Units, on Grade	A	3	0.75"
Packaged Water-Cooled Indoor Air Conditioning Units, on Concrete Structure	A	3	1.50"
Packaged Water-Cooled Indoor Air Conditioning Units, on Steel Structure	C	3	2.50"
Packaged Air Conditioning Unit, on Grade	A	2	0.25"
Packaged Rooftop Air Conditioning Unit or Heat Pump, on Roof	D	4	2.50"
Piping			
Chilled Water, Hot Water Piping First 5 Hangers from Boilers, Chillers, Heat Exchangers, and Pumps	A	3B	0.75"

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

Equipment	Base Type	Isolator Type	Deflection
Ductwork			
In Mechanical Rooms	A	3B	0.25"
Miscellaneous Equipment			
Engine Driven Generator, on Grade	A	3	0.75"
Engine Driven Generator, on Concrete Structure	C	3	1.50"
Engine Driven Generator, on Steel Structure	C	3	2.50"

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following mechanical identification materials and their installation:
   1. Equipment nameplates.
   2. Access panel and door markers.
   3. Pipe markers.
   4. Duct markers.
   5. Stencils.
   6. Valve tags.
   7. Valve schedules.

1.3 SUBMITTALS

A. Valve numbering scheme.

B. Valve Schedules: For each piping system. Furnish extra copies (in addition to mounted copies) to include in maintenance manuals.

1.4 QUALITY ASSURANCE

A. ASME Compliance: Comply with ASME A13.1, "Scheme for the Identification of Piping Systems," for letter size, length of color field, colors, and viewing angles of identification devices for piping.

1.5 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with location of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT IDENTIFICATION DEVICES

A. Equipment Nameplates: Metal, with data engraved or stamped, for permanent attachment on equipment.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1. Data:
   a. Manufacturer, product name, model number, and serial number.
   b. Capacity, operating and power characteristics, and essential data.
   c. Labels of tested compliances.
2. Location: Accessible and visible.
3. Fasteners: As required to mount on equipment.

B. Access Panel and Door Markers: 1/16-inch-(1.6-mm-) thick, engraved laminated plastic, with abbreviated terms and numbers corresponding to identification. Provide 1/8-inch(3.2-mm) center hole for attachment.
1. Fasteners: Self-tapping, stainless-steel screws or contact-type, permanent adhesive.

2.2 PIPING IDENTIFICATION DEVICES

A. Manufactured Pipe Markers, General: Preprinted, color-coded, with lettering indicating service, and showing direction of flow.
1. Colors: Comply with ASME A13.1, unless otherwise indicated.
2. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length.
3. Pipes with OD, Including Insulation, Less Than 6 Inches(150 mm): Full-band pipe markers extending 360 degrees around pipe at each location.
4. Pipes with OD, Including Insulation, 6 Inches(150 mm) and Larger: Either full-band or strip-type pipe markers at least three times letter height and of length required for label.
5. Arrows: Integral with piping system service lettering to accommodate both directions; or as separate unit on each pipe marker to indicate direction of flow.

B. Self-Adhesive Pipe Markers: Plastic with pressure-sensitive, permanent-type, self-adhesive back.

C. Plastic Tape: Continuously printed, vinyl tape at least 3 mils(0.08 mm) thick with pressure-sensitive, permanent-type, self-adhesive back.
1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches (150 mm): 3/4 inch(19 mm) minimum.
2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches(150 mm) or Larger: 1-1/2 inches(38 mm) minimum.

2.3 STENCILS

A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; minimum letter height of 1-1/4 inches(32 mm) for ducts; and minimum letter height of 3/4 inch(19 mm) for access panel and door markers, equipment markers, equipment signs, and similar operational instructions.
1. Stencil Paint: Exterior, gloss, acrylic enamel black, unless otherwise indicated. Paint may be in pressurized spray-can form.
2. Identification Paint: Exterior, acrylic enamel in colors according to ASME A13.1, unless otherwise indicated.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2.4 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch(6.4-mm) letters for piping system abbreviation and 1/2-inch(13-mm) numbers, with numbering scheme approved by Owner. Provide 5/32-inch(4-mm) hole for fastener.
   1. Material: 0.0375-inch-(1-mm-) thick stainless steel.
   2. Valve-Tag Fasteners: To match tag material.

2.5 VALVE SCHEDULES

A. Valve Schedules: For each piping system, on standard-size bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space). Mark valves for emergency shutoff and similar special uses.
   1. Valve-Schedule Frames: Glazed display frame for removable mounting on masonry walls for each page of valve schedule. Include mounting screws.
   2. Frame: Extruded aluminum.
   3. Glazing: ASTM C 1036, Type I, Class 1, Glazing Quality B, 2.5-mm, single-thickness glass.

PART 3 - EXECUTION

3.1 APPLICATIONS, GENERAL

A. Products specified are for applications referenced in other Division 23 Sections. If more than single-type material, device, or label is specified for listed applications, selection is Installer's option.

3.2 EQUIPMENT IDENTIFICATION

A. Install and permanently fasten equipment nameplates on each major item of mechanical equipment that does not have nameplate or has nameplate that is damaged or located where not easily visible. Locate nameplates where accessible and visible. Include nameplates for the following general categories of equipment:
   1. Fuel-burning units, including boilers, furnaces, heaters, stills, and absorption units.
   2. Pumps, condensing units, and similar motor-driven units.
   3. Coils, heat recovery units, and similar equipment.
   4. Fans, blowers, primary balancing dampers, and mixing boxes.
   5. Packaged HVAC central-station and zone-type units.
   6. Flow meters.

3.3 PIPING IDENTIFICATION

A. Install manufactured pipe markers indicating service on each piping system. Install with flow indication arrows showing direction of flow.
   1. Pipes with OD, Including Insulation, Less Than 6 Inches(150 mm): Self-adhesive pipe markers. Use color-coded, self-adhesive plastic tape, 1-1/2 inches(38 mm) wide, lapped at least 1-1/2 inches(38 mm) at both ends of pipe marker, and covering full circumference of pipe.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2. Pipes with OD, Including Insulation, 6 Inches(150 mm) and Larger: Self-adhesive pipe markers. Use color-coded, self-adhesive plastic tape, at least 1-1/2 inches(38 mm) wide, lapped at least 3 inches(75 mm) at both ends of pipe marker, and covering full circumference of pipe.

B. Stenciled Pipe Marker Option: Stenciled markers may be provided instead of manufactured pipe markers, at Installer's option. Install stenciled pipe markers on each piping system.
   1. Identification Paint: Use for contrasting background.
   2. Stencil Paint: Use for pipe marking.

C. Locate pipe markers and color bands where piping is exposed in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior nonconcealed locations as follows:
   1. Near each valve and control device.
   2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
   3. Near penetrations through walls, floors, ceilings, and nonaccessible enclosures.
   4. At access doors, manholes, and similar access points that permit view of concealed piping.
   5. Near major equipment items and other points of origination and termination.
   6. Spaced at maximum intervals of 50 feet(15 m) along each run, unless otherwise indicated. Reduce intervals to 25 feet(7.6 m) in mechanical/plumbing rooms.
   7. On piping above removable acoustical ceiling, omit intermediately spaced markers.

3.4 DUCT IDENTIFICATION

A. Stenciled Duct Marker Option: Stenciled markers, showing service and direction of flow, for hazardous material exhaust ducts shall be provided with lettering 2 inch(50 mm) high for proper identification.
   1. ASME A13.1 Color and Design: For hazardous material exhaust.

B. Locate markers near points where ducts enter into concealed spaces and at maximum intervals of 50 feet(15 m) in each space where ducts are exposed or concealed by removable ceiling system.

3.5 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; plumbing fixture supply stops; shutoff valves; faucets; convenience and lawn-watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule. Valve tags shall be minimum 1-1/2 inches (38 mm) round.

3.6 VALVE-SCHEDULE INSTALLATION

A. Mount valve schedule on wall in accessible location in each major equipment room.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3.7 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

3.8 ADJUSTING

A. Relocate mechanical identification materials and devices that have become visually blocked by other work.

3.9 CLEANING

A. Clean faces of mechanical identification devices and glass frames of valve schedules.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes TAB to produce design objectives for the following:
   1. Air Systems:
      a. Constant-volume air systems.
   2. Hydronic Piping Systems:
      a. Constant-flow systems.
   3. HVAC equipment quantitative-performance settings.
   4. Space pressurization testing and adjusting.
   5. Existing conditions verification to insure that system modifications do not affect areas outside scope of work.
   6. Verifying that automatic control devices are functioning properly.
   7. Reporting results of activities and procedures specified in this Section.

1.3 DEFINITIONS

A. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.

B. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to indicated quantities.

C. Barrier or Boundary: Construction, either vertical or horizontal, such as walls, floors, and ceilings that are designed and constructed to restrict the movement of airflow, smoke, odors, and other pollutants.

D. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.

E. NC: Noise criteria.

F. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.

G. RC: Room criteria.

H. Report Forms: Test data sheets for recording test data in logical order.

I. Smoke-Control Zone: A space within a building that is enclosed by smoke barriers and is a part of a zoned smoke-control system.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

J. Static Head: The pressure due to the weight of the fluid above the point of measurement. In a closed system, static head is equal on both sides of the pump.

K. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.

L. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

M. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.

N. TAB: Testing, adjusting, and balancing.

O. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.

P. Test: A procedure to determine quantitative performance of systems or equipment.

Q. Testing, Adjusting, and Balancing (TAB) Firm: The entity responsible for performing and reporting TAB procedures.

1.4 SUBMITTALS

A. Qualification Data: Within 15 days from Contractor's Notice to Proceed, submit 2 copies of evidence that TAB firm and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Existing Systems Verification: Within 30 days from Contractor’s Notice to Proceed, submit 2 copies of certified existing systems verification test and balance report.

C. Contract Documents Examination Report: Within 45 days from Contractor's Notice to Proceed, submit 2 copies of the Contract Documents review report as specified in Part 3.

D. Strategies and Procedures Plan: Within 60 days from Contractor's Notice to Proceed, submit 2 copies of TAB strategies and step-by-step procedures as specified in Part 3 "Preparation" Article. Include a complete set of report forms intended for use on this Project.

E. Certified TAB Reports: Submit two copies of reports prepared, as specified in this Section, on approved forms certified by TAB firm.

F. Sample Report Forms: Submit two sets of sample TAB report forms.

G. Warranties specified in this Section.

1.5 QUALITY ASSURANCE

A. TAB Firm Qualifications: Engage a TAB firm certified by either AABC or NEBB.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. TAB Conference: Meet with Owner's and Architect's representatives on approval of TAB strategies and procedures plan to develop a mutual understanding of the details. Ensure the participation of TAB team members, equipment manufacturers' authorized service representatives, HVAC controls installers, and other support personnel. Provide seven days' advance notice of scheduled meeting time and location.
   1. Agenda Items: Include at least the following:
      a. Submittal distribution requirements.
      b. The Contract Documents examination report.
      c. TAB plan.
      d. Work schedule and Project-site access requirements.
      e. Coordination and cooperation of trades and subcontractors.
      f. Coordination of documentation and communication flow.

C. Certification of TAB Reports: Certify TAB field data reports. This certification includes the following:
   1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
   2. Certify that TAB team complied with approved TAB plan and the procedures specified and referenced in this Specification.

D. TAB Report Forms: Use standard forms from AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems".

E. Instrumentation Type, Quantity, and Accuracy: As described in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems", Section II, "Required Instrumentation for NEBB Certification".

F. Instrumentation Calibration: Calibrate instruments at least every six months or more frequently if required by instrument manufacturer.
   1. Keep an updated record of instrument calibration that indicates date of calibration and the name of party performing instrument calibration.

1.6 PROJECT CONDITIONS

A. Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.7 COORDINATION

A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.

B. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

C. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

1.8 WARRANTY

A. General Warranty: The national project performance guarantee specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be addition to, and run concurrent with other warranties made by Contractor under requirements of the Contract Documents.

B. National Project Performance Guarantee: Provide a guarantee on AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" forms stating that AABC will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents. Guarantee includes the following provisions:
   1. The certified TAB firm has tested and balanced systems according to the Contract Documents.
   2. Systems are balanced to optimum performance capabilities within design and installation limits.

C. Special Guarantee: Provide a guarantee on NEBB forms stating that NEBB will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents. Guarantee shall include the following provisions:
   1. The certified TAB firm has tested and balanced systems according to the Contract Documents.
   2. Systems are balanced to optimum performance capabilities within design and installation limits.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
   1. Contract Documents are defined in the General and Supplementary Conditions of Contract.
   2. Verify that balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.

B. Examine approved submittal data of HVAC systems and equipment.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

C. Examine Project Record Documents described in Division 01 Section "Project Record Documents."

D. Examine design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine equipment performance data including fan curves. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system. Calculate system effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from those presented when the equipment was performance tested at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," Sections 7 through 10; or in SMACNA's "HVAC Systems--Duct Design," Sections 5 and 6. Compare this data with the design data and installed conditions.

F. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Sections have been performed.

G. Examine system and equipment test reports.

H. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.

I. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.

J. Examine HVAC equipment to ensure that clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

K. Examine plenum ceilings used for supply air to verify that they are airtight. Verify that pipe penetrations and other holes are sealed.

L. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.

M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

N. Examine equipment for installation and for properly operating safety interlocks and controls.

O. Examine automatic temperature system components to verify the following:
   1. Dampers, valves, and other controlled devices are operated by the intended controller.
   2. Dampers and valves are in the position indicated by the controller.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in multizone units, mixing boxes, and variable-air-volume terminals.
4. Automatic modulating and shutoff valves, including two-way valves and three-way mixing and diverting valves, are properly connected.
5. Thermostats and humidistats are located to avoid adverse effects of sunlight, drafts, and cold walls.
6. Sensors are located to sense only the intended conditions.
7. Sequence of operation for control modes is according to the Contract Documents.
8. Controller set points are set at indicated values.
9. Interlocked systems are operating.
10. Changeover from heating to cooling mode occurs according to indicated values.

P. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Prepare a TAB plan that includes strategies and step-by-step procedures.

B. Complete system readiness checks and prepare system readiness reports. Verify the following:
1. Permanent electrical power wiring is complete.
2. Hydronic systems are filled, clean, and free of air.
3. Automatic temperature-control systems are operational.
4. Equipment and duct access doors are securely closed.
5. Balance, smoke, and fire dampers are open.
6. Isolating and balancing valves are open and control valves are operational.
7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
8. Windows and doors can be closed so indicated conditions for system operations can be met.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and this Section.

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to insulation Specifications for this Project.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

C. Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, to show final settings.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. Determine the best locations in main and branch ducts for accurate duct airflow measurements.

D. Check airflow patterns from the outside-air louvers and dampers and the return- and exhaust-air dampers, through the supply-fan discharge and mixing dampers.

E. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

F. Verify that motor starters are equipped with properly sized thermal protection.

G. Check dampers for proper position to achieve desired airflow path.

H. Check for airflow blockages.

I. Check condensate drains for proper connections and functioning.

J. Check for proper sealing of air-handling unit components.

K. Check for proper sealing of air duct system.

3.5 BASIC AIR SYSTEMS' BALANCING PROCEDURES

A. The procedures in this Article apply to constant-volume supply-, return-, and exhaust-air systems. Additional procedures are required for variable air volume, multizone, dual duct, induction unit supply air systems, and process exhaust air systems. These additional procedures are specified in other articles in this Section.

B. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
   1. Measure fan static pressures to determine actual static pressure as follows:
      a. Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.
      b. Measure static pressure directly at the fan outlet or through the flexible connection.
      c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.

2. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
   a. Simulate dirty filter operation and record the point at which maintenance personnel must change filters.
3. Measure static pressures entering and leaving other devices such as sound traps, heat recovery equipment, and air washers, under final balanced conditions.
4. Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Compare actual system effect factors with calculated system effect factors to identify where variations occur.
   a. Adjust fan speed higher or lower than design and make required adjustments to pulley sizes, motor sizes, and electrical connections to accommodate fan-speed changes.
   b. Recommend corrective actions to align design and actual conditions.
5. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full cooling, full heating, economizer, and any other operating modes to determine the maximum required brake horsepower.

C. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
   1. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved.
      a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
   2. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.

D. Measure terminal outlets and inlets without making adjustments.
   1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

E. Adjust terminal outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using volume dampers rather than extractors and the dampers at air terminals.
   1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
   2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.6 PROCEDURES FOR MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
   1. Manufacturer, model, and serial numbers.
   2. Motor horsepower rating.
   3. Motor rpm.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

4. Efficiency rating.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter thermal-protection-element rating.

B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass for the controller to prove proper operation. Record observations, including controller manufacturer, model and serial numbers, and nameplate data.

3.7 PROCEDURES FOR CONDENSING UNITS

A. Verify proper rotation of fans.

B. Measure entering- and leaving-air temperatures.

C. Record compressor data.

3.8 PROCEDURES FOR HEAT-TRANSFER COILS

A. Water Coils: Measure the following data for each coil:
1. Entering- and leaving-water temperature.
2. Water flow rate.
3. Water pressure drop.
4. Dry-bulb temperature of entering and leaving air.
5. Wet-bulb temperature of entering and leaving air for cooling coils.
6. Airflow.
7. Air pressure drop.

B. Electric-Heating Coils: Measure the following data for each coil:
1. Nameplate data.
2. Airflow.
3. Entering- and leaving-air temperature at full load.
4. Voltage and amperage input of each phase at full load and at each incremental stage.
5. Calculated kilowatt at full load.
6. Fuse or circuit-breaker rating for overload protection.

C. Refrigerant Coils: Measure the following data for each coil:
1. Dry-bulb temperature of entering and leaving air.
2. Wet-bulb temperature of entering and leaving air.
3. Airflow.
4. Air pressure drop.
5. Refrigerant suction pressure and temperature.

3.9 PROCEDURES FOR TEMPERATURE MEASUREMENTS

A. During TAB, report the need for adjustment in temperature regulation within the automatic temperature-control system.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Measure indoor wet- and dry-bulb temperatures every other hour for a period of two successive eight-hour days, in each separately controlled zone, to prove correctness of final temperature settings. Measure when the building or zone is occupied.

C. Measure outside-air, wet- and dry-bulb temperatures.

3.10 PROCEDURES FOR SPACE PRESSURIZATION MEASUREMENTS AND ADJUSTMENTS

A. Before testing for space pressurization, observe the space to verify the integrity of the space boundaries. Verify that windows and doors are closed and applicable safing, gaskets, and sealants are installed. Report deficiencies and postpone testing until after the reported deficiencies are corrected.

B. Measure, adjust, and record the pressurization of each room, each zone, and each building by adjusting the supply, return, and exhaust airflows to achieve the indicated conditions.

C. Measure space pressure differential where pressure is used as the design criteria, and measure airflow differential where differential airflow is used as the design criteria for space pressurization.
   1. For pressure measurements, measure and record the pressure difference between the intended spaces at the door with all doors in the space closed. Record the high-pressure side, low-pressure side, and pressure difference between each adjacent space.
   2. For applications with cascading levels of space pressurization, begin in the most critical space and work to the least critical space.
   3. Test room pressurization first, then zones, and finish with building pressurization.

D. To achieve indicated pressurization, set the supply airflow to the indicated conditions and adjust the exhaust and return airflow to achieve the indicated pressure or airflow difference.

E. For spaces with pressurization being monitored and controlled automatically, observe and adjust the controls to achieve the desired set point.
   1. Compare the values of the measurements taken to the measured values of the control system instruments and report findings.
   2. Check the repeatability of the controls by successive tests designed to temporarily alter the ability to achieve space pressurization. Test overpressurization and underpressurization, and observe and report on the system's ability to revert to the set point.
   3. For spaces served by variable-air-volume supply and exhaust systems, measure space pressurization at indicated airflow and minimum airflow conditions.

F. In spaces that employ multiple modes of operation, such as normal mode and emergency mode or occupied mode and unoccupied mode, measure, adjust, and record data for each operating mode.

G. Record indicated conditions and corresponding initial and final measurements. Report deficiencies.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3.11 PROCEDURES FOR SMOKE-CONTROL SYSTEM TESTING

A. Before testing smoke-control systems, verify that construction is complete and verify the integrity of each smoke-control zone boundary. Verify that windows and doors are closed and that applicable safing, gasket, and sealants are installed. Report deficiencies and postpone testing until after the reported deficiencies are corrected.

B. Measure and record wind speed and direction, outside-air temperature, and relative humidity on each test day.

C. Measure, adjust, and record airflow of each smoke-control system with all fans that are a part of the system operating as intended by the design.

D. Measure, adjust, and record the airflow of each fan. For ducted systems, measure the fan airflow by duct Pitot-tube traverse.

E. After air balancing is complete, perform the following pressurization testing for each smoke-control zone in the system:
   1. Verify the boundaries of each smoke-control zone.
   2. With the HVAC systems in their normal mode of operation and smoke control not operating, measure and record the pressure difference across each smoke-control zone. Make measurements after closing doors that separate the zones. Make one measurement across each door. Clearly indicate the high and low pressure side of each door.
   3. With the system operating in the smoke-control mode and with each zone in the smoke-control system activated, perform the following:
      a. Measure and record the pressure difference across each door that separates the smoke zone from adjacent zones. Make measurements with doors that separate the smoke zone from the other zones closed. Clearly indicate the high and low pressure side of the door. Doors that have a tendency to open slightly due to the pressure difference should have one pressure measurement made while held closed and another measurement made with the door open.
      b. Continue to activate each separate zoned smoke-control system and make pressure difference measurements.
      c. After testing a smoke zone's smoke-control system, deactivate the HVAC systems involved and return them to their normal operating mode before activating another zone's smoke-control system.
      d. Verify that controls necessary to prevent excessive pressure differences are functional.

F. Operational Tests:
   1. Check the proper activation of each zoned smoke-control system in response to all means of activation, both automatic and manual.
   2. Check automatic activation in response to fire alarm signals received from the building's fire alarm and detection system. Initiate a separate alarm for each means of activation to ensure that the proper operation of the correct zoned smoke-control system occurs.
   3. Check and record proper operation of fans, dampers, and related equipment as outlined below for each separate zone of the smoke-control system.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

a. Fire zone in which a smoke-control system automatically activates.
b. Type of signal that activates a smoke-control system, such as pull station, sprinkler water flow, or smoke detector.
c. Smoke zone(s) where maximum mechanical exhaust to the outside is implemented and no supply air is provided.
d. Positive pressure smoke-control zone(s) where maximum air supply is implemented and no exhaust to the outside is provided.
e. Fan(s) "ON" as required to implement the smoke-control system. Multiple- or variable-speed fans should be further noted as "MAX. VOLUME" to verify that the intended control configuration is achieved.
f. Fan(s) "OFF" as required to implement the smoke-control system.
g. Damper(s) "OPEN" where maximum airflow must be achieved.
h. Damper(s) "CLOSED" where no airflow should take place.
i. Auxiliary functions to achieve the smoke-control system configuration such as changes or override of normal operating pressure and temperature-control set points.
j. If standby power is provided for the smoke-control system, test to verify that the system functions while operating under both normal and standby power.

G. Conduct additional tests required by authorities having jurisdiction. Unless required by authorities having jurisdiction, perform testing without the use of smoke or products that simulate smoke.

H. Prepare a complete report of observations, measurements, and deficiencies.

3.12 TEMPERATURE-CONTROL VERIFICATION

A. Verify that controllers are calibrated and commissioned.

B. Check transmitter and controller locations and note conditions that would adversely affect control functions.

C. Record controller settings and note variances between set points and actual measurements.

D. Check the operation of limiting controllers (i.e., high- and low-temperature controllers).

E. Check free travel and proper operation of control devices such as damper and valve operators.

F. Check the sequence of operation of control devices. Note air pressures and device positions and correlate with airflow and water flow measurements. Note the speed of response to input changes.

G. Check the interaction of electrically operated switch transducers.

H. Check the interaction of interlock and lockout systems.

I. Check main control supply-air pressure and observe compressor and dryer operations.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

J. Record voltages of power supply and controller output. Determine whether the system operates on a grounded or nongrounded power supply.

K. Note operation of electric actuators using spring return for proper fail-safe operations.

3.13 TOLERANCES

A. Set HVAC system airflow and water flow rates within the following tolerances:
   1. Supply, Return, and Exhaust Fans and Equipment with Fans: 0 to plus 5 percent.
   2. Air Outlets and Inlets: minus 8 to plus 5 percent.
   3. Heating-Water Flow Rate: 0 to minus 10 percent.
   4. Cooling-Water Flow Rate: 0 to minus 5 percent.

3.14 REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

B. Status Reports: As Work progresses, prepare reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.15 FINAL REPORT

A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in three-ring binder, tabulated and divided into sections by tested and balanced systems.

B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.
   1. Include a list of instruments used for procedures, along with proof of calibration.

C. Final Report Contents: In addition to certified field report data, include the following:
   1. Pump curves.
   2. Fan curves.
   3. Manufacturers' test data.
   4. Field test reports prepared by system and equipment installers.
   5. Other information relative to equipment performance, but do not include Shop Drawings and Product Data.

D. General Report Data: In addition to form titles and entries, include the following data in the final report, as applicable:
   1. Title page.
   2. Name and address of TAB firm.
   3. Project name.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of TAB firm who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents including the following:
    a. Indicated versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.
12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer, type size, and fittings.
14. Notes to explain why certain final data in the body of reports varies from indicated values.
15. Test conditions for fans and pump performance forms including the following:
    a. Settings for outside-, return-, and exhaust-air dampers.
    b. Conditions of filters.
    c. Cooling coil, wet- and dry-bulb conditions.
    d. Face and bypass damper settings at coils.
    e. Fan drive settings including settings and percentage of maximum pitch diameter.
    f. Inlet vane settings for variable-air-volume systems.
    g. Settings for supply-air, static-pressure controller.
    h. Other system operating conditions that affect performance.

E. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
1. Quantities of outside, supply, return, and exhaust airflows.
2. Water and steam flow rates.
3. Duct, outlet, and inlet sizes.
4. Pipe and valve sizes and locations.
5. Terminal units.
6. Balancing stations.
7. Position of balancing devices.

F. Air-Handling Unit Test Reports: For air-handling units with coils, include the following:
1. Unit Data: Include the following:
    a. Unit identification.
    b. Location.
    c. Make and type.
    d. Model number and unit size.
    e. Manufacturer's serial number.
    f. Unit arrangement and class.
    g. Discharge arrangement.
    h. Sheave make, size in inches (mm), and bore.
    i. Sheave dimensions, center-to-center, and amount of adjustments in inches (mm).

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

j. Number of belts, make, and size.
k. Number of filters, type, and size.

2. Motor Data:
   a. Make and frame type and size.
   b. Horsepower and rpm.
   c. Volts, phase, and hertz.
   d. Full-load amperage and service factor.
   e. Sheave make, size in inches (mm), and bore.
   f. Sheave dimensions, center-to-center, and amount of adjustments in inches (mm).
3. Test Data (Indicated and Actual Values):
   a. Total airflow rate in cfm (L/s).
   b. Total system static pressure in inches wg (Pa).
   c. Fan rpm.
   d. Discharge static pressure in inches wg (Pa).
   e. Filter static-pressure differential in inches wg (Pa).
   f. Preheat coil static-pressure differential in inches wg (Pa).
   g. Cooling coil static-pressure differential in inches wg (Pa).
   h. Heating coil static-pressure differential in inches wg (Pa).
   i. Outside airflow in cfm (L/s).
   j. Return airflow in cfm (L/s).
   k. Outside-air damper position.
   l. Return-air damper position.
   m. Vortex damper position.

G. Apparatus-Coil Test Reports:
1. Coil Data:
   a. System identification.
   b. Location.
   c. Coil type.
   d. Number of rows.
   e. Fin spacing in fins per inch (mm) o.c.
   f. Make and model number.
   g. Face area in sq. ft. (sq. m).
   h. Tube size in NPS (DN).
   i. Tube and fin materials.
   j. Circuiting arrangement.
2. Test Data (Indicated and Actual Values):
   a. Airflow rate in cfm (L/s).
   b. Average face velocity in fpm (m/s).
   c. Air pressure drop in inches wg (Pa).
   d. Outside-air, wet- and dry-bulb temperatures in deg F (deg C).
   e. Return-air, wet- and dry-bulb temperatures in deg F (deg C).
   f. Entering-air, wet- and dry-bulb temperatures in deg F (deg C).
   g. Leaving-air, wet- and dry-bulb temperatures in deg F (deg C).
   h. Water flow rate in gpm (L/s).
   i. Water pressure differential in feet of head or psig (kPa).
   j. Entering-water temperature in deg F (deg C).
   k. Leaving-water temperature in deg F (deg C).

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

l. Refrigerant expansion valve and refrigerant types.
m. Refrigerant suction pressure in psig (kPa).
n. Refrigerant suction temperature in deg F (deg C).
o. Inlet steam pressure in psig (kPa).

H. Gas- and Oil-Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:
1. Unit Data:
a. System identification.
b. Location.
c. Make and type.
d. Model number and unit size.
e. Manufacturer's serial number.
f. Fuel type in input data.
g. Output capacity in Btuh (kW).
h. Ignition type.
i. Burner-control types.
j. Motor horsepower and rpm.
k. Motor volts, phase, and hertz.
l. Motor full-load amperage and service factor.
m. Sheave make, size in inches (mm), and bore.
n. Sheave dimensions, center-to-center, and amount of adjustments in inches (mm).
2. Test Data (Indicated and Actual Values):
a. Total airflow rate in cfm (L/s).
b. Entering-air temperature in deg F (deg C).
c. Leaving-air temperature in deg F (deg C).
d. Air temperature differential in deg F (deg C).
e. Entering-air static pressure in inches wg (Pa).
f. Leaving-air static pressure in inches wg (Pa).
g. Air static-pressure differential in inches wg (Pa).
h. Low-fire fuel input in Btuh (kW).
i. High-fire fuel input in Btuh (kW).
j. Manifold pressure in psig (kPa).
k. High-temperature-limit setting in deg F (deg C).
l. Operating set point in Btuh (kW).
m. Motor voltage at each connection.
n. Motor amperage for each phase.
o. Heating value of fuel in Btuh (kW).

I. Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central-station air-handling units, include the following:
1. Unit Data:
a. System identification.
b. Location.
c. Coil identification.
d. Capacity in Btuh (kW).
e. Number of stages.
f. Connected volts, phase, and hertz.
g. Rated amperage.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

h. Airflow rate in cfm (L/s).
i. Face area in sq. ft. (sq. m).
j. Minimum face velocity in fpm (m/s).

2. Test Data (Indicated and Actual Values):
   a. Heat output in Btuh (kW).
   b. Airflow rate in cfm (L/s).
   c. Air velocity in fpm (m/s).
   d. Entering-air temperature in deg F (deg C).
   e. Leaving-air temperature in deg F (deg C).
   f. Voltage at each connection.
   g. Amperage for each phase.

J. Fan Test Reports: For supply, return, and exhaust fans, include the following:
   1. Fan Data:
      a. System identification.
      b. Location.
      c. Make and type.
      d. Model number and size.
      e. Manufacturer's serial number.
      f. Arrangement and class.
      g. Sheave make, size in inches (mm), and bore.
      h. Sheave dimensions, center-to-center, and amount of adjustments in inches (mm).
   2. Motor Data:
      a. Make and frame type and size.
      b. Horsepower and rpm.
      c. Volts, phase, and hertz.
      d. Full-load amperage and service factor.
      e. Sheave make, size in inches (mm), and bore.
      f. Sheave dimensions, center-to-center, and amount of adjustments in inches (mm).
      g. Number of belts, make, and size.
   3. Test Data (Indicated and Actual Values):
      a. Total airflow rate in cfm (L/s).
      b. Total system static pressure in inches wg (Pa).
      c. Fan rpm.
      d. Discharge static pressure in inches wg (Pa).
      e. Suction static pressure in inches wg (Pa).

K. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
   1. Report Data:
      a. System and air-handling unit number.
      b. Location and zone.
      c. Traverse air temperature in deg F (deg C).
      d. Duct static pressure in inches wg (Pa).
      e. Duct size in inches (mm).
      f. Duct area in sq. ft. (sq. m).
      g. Indicated airflow rate in cfm (L/s).
      h. Indicated velocity in fpm (m/s).

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

i. Actual airflow rate in cfm (L/s).
j. Actual average velocity in fpm (m/s).
k. Barometric pressure in psig (Pa).

L. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:
1. Unit Data:
a. System and air-handling unit identification.
b. Location and zone.
c. Room or riser served.
d. Coil make and size.
e. Flowmeter type.
2. Test Data (Indicated and Actual Values):
a. Airflow rate in cfm (L/s).
b. Entering-water temperature in deg F (deg C).
c. Leaving-water temperature in deg F (deg C).
d. Water pressure drop in feet of head or psig (kPa).
e. Entering-air temperature in deg F (deg C).
f. Leaving-air temperature in deg F (deg C).

M. Air-to-Air Heat-Recovery Unit Reports:
1. Unit Data:
a. Unit identification.
b. Location.
c. Service.
d. Make and type.
e. Model and serial numbers.
2. Motor Data:
a. Make and frame type and size.
b. Horsepower and rpm.
c. Volts, phase, and hertz.
d. Full load amperage and service factor.
e. Sheave make, size in inches (mm), and bore.
f. Sheave dimensions, center-to-center, and amount of adjustments in inches (mm).
3. If fans are an integral part of the unit, include the following for each fan:
a. Make and type.
b. Arrangement and size.
c. Sheave make, size in inches (mm), and bore.
d. Sheave dimensions, center-to-center, and amount of adjustments in inches (mm).
4. Test Data (Indicated and Actual Values):
a. Total exhaust airflow rate in cfm (L/s).
b. Purge exhaust airflow rate in cfm (L/s).
c. Outside airflow rate in cfm (L/s).
d. Total exhaust fan static pressure in inches wg (Pa).
e. Total outside-air fan static pressure in inches wg (Pa).
f. Pressure drop on each side of recovery wheel in inches wg (Pa).
g. Exhaust air temperature entering in deg F (deg C).
h. Exhaust air temperature leaving in deg F (deg C).
i. Outside-air temperature entering in deg F (deg C).

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

j. Outside-air temperature leaving in deg F (deg C).
k. Calculate sensible and total heat capacity of each airstream in MBh (kW).

N. Instrument Calibration Reports:
1. Report Data:
a. Instrument type and make.
b. Serial number.
c. Application.
d. Dates of use.
e. Dates of calibration.

3.16 INSPECTIONS

A. Initial Inspection:
1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the Final Report.
2. Randomly check the following for each system:
a. Measure airflow of at least 10 percent of air outlets.
b. Measure water flow of at least 5 percent of terminals.
c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
d. Measure sound levels at two locations.
e. Measure space pressure of at least 10 percent of locations.
f. Verify that balancing devices are marked with final balance position.
g. Note deviations to the Contract Documents in the Final Report.

B. Final Inspection:
1. After initial inspection is complete and evidence by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by the Owner.
2. TAB firm test and balance engineer shall conduct the inspection in the presence of the Owner.
3. The Owner shall randomly select measurements documented in the final report to be rechecked. The rechecking shall be limited to either 10 percent of the total measurements recorded, or the extent of measurements that can be accomplished in a normal 8-hour business day.
4. If the rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.
6. TAB firm shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes and resubmit the final report.
7. Request a second final inspection. If the second final inspection also fails, Owner shall contract the services of another TAB firm to complete the testing and balancing in accordance with the Contract Documents and deduct the cost of the services from the final payment.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3.17 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional testing and balancing to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional testing, inspecting, and adjusting during near-peak summer and winter conditions.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Insulation Materials:
      a. Flexible elastomeric.
      b. Mineral fiber.
   2. Fire-rated insulation systems.
   3. Insulating cements.
   4. Adhesives.
   5. Mastics.
   6. Lagging adhesives.
   7. Sealants.
   8. Factory-applied jackets.
   9. Field-applied fabric-reinforcing mesh.
   10. Field-applied cloths.
   11. Field-applied jackets.
   12. Tapes.
   13. Securements.
   14. Corner angles.

B. Related Sections:
   1. Division 22 Section "Plumbing Insulation."
   2. Division 23 Section "Metal Ducts" for duct liners.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).

B. Qualification Data: For qualified Installer.

C. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program in the field of HVAC insulation applications. Installer shall be a company specializing in HVAC insulation applications. Insulation shall be installed in a neat, workmanlike manner.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
   1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
   2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct insulation application, and equipment Installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.7 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Aeroflex USA Inc.; Aerocel.
      b. Armacell LLC; AP Armaflex.
      c. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.
      d. Or approved equal.

G. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. CertainTeed Corp.; Duct Wrap.
      b. Johns Manville; Microlite.
      c. Knauf Insulation; Duct Wrap.
      d. Manson Insulation Inc.; Alley Wrap.
      e. Owens Corning; All-Service Duct Wrap.
      f. Or approved equal.

H. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied ASJ. For equipment applications, provide insulation with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. CertainTeed Corp.; Commercial Board.
      b. Fibrex Insulations Inc.; FBX.
      c. Johns Manville; 800 Series Spin-Glas.
      d. Knauf Insulation; Insulation Board.
      e. Manson Insulation Inc.; AK Board.
      f. Owens Corning; Fiberglas 700 Series.
      g. Or approved equal.

I. Mineral-Fiber, Preformed Pipe Insulation:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Fibrex Insulations Inc.; Coreplus 1200.
      b. Johns Manville; Micro-Lok.
      c. Knauf Insulation; 1000 Pipe Insulation.
      d. Manson Insulation Inc.; Alley-K.
      e. Owens Corning; Fiberglas Pipe Insulation.
      f. Or approved equal.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2. Type I, 850 deg F (454 deg C) Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Insulco, Division of MFS, Inc.; Triple I.
   b. P. K. Insulation Mfg. Co., Inc.; Super-Stik.
   c. Or approved equal.

2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Aeroflex USA Inc.; Aeroseal.
   b. Armacell LCC; 520 Adhesive.
   c. Foster Products Corporation, H. B. Fuller Company; 85-75.
   d. RBX Corporation; Rubatex Contact Adhesive.
   e. Or approved equal.

C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Childers Products, Division of ITW; CP-82.
   b. Foster Products Corporation, H. B. Fuller Company; 85-20.
   c. ITW TACC, Division of Illinois Tool Works; S-90/80.
   d. Marathon Industries, Inc.; 225.
   e. Mon-Eco Industries, Inc.; 22-25.
   f. Or approved equal.

D. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Childers Products, Division of ITW; CP-82.
   b. Foster Products Corporation, H. B. Fuller Company; 85-20.
   c. ITW TACC, Division of Illinois Tool Works; S-90/80.
   d. Marathon Industries, Inc.; 225.
   e. Mon-Eco Industries, Inc.; 22-25.
   f. Or approved equal.

E. PVC Jacket Adhesive: Compatible with PVC jacket.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Dow Chemical Company (The); 739, Dow Silicone.
   b. Johns-Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

c. P.I.C. Plastics, Inc.; Welding Adhesive.
d. Red Devil, Inc.; Celulon Ultra Clear.
e. Speedline Corporation; Speedline Vinyl Adhesive.
f. Or approved equal.

2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.

B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.
1. Products: Subject to compliance with requirements, provide one of the following:
a. Childers Products, Division of ITW; CP-35.
b. Foster Products Corporation, H. B. Fuller Company; 30-90.
c. ITW TACC, Division of Illinois Tool Works; CB-50.
d. Marathon Industries, Inc.; 590.
e. Mon-Eco Industries, Inc.; 55-40.
f. Vimasco Corporation; 749.
g. Or approved equal.
2. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm (0.009 metric perm) at 43-mil (1.09-mm) dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).
4. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
5. Color: White.

2.5 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
1. Products: Subject to compliance with requirements, provide one of the following:
a. Childers Products, Division of ITW; CP-52.
b. Foster Products Corporation, H. B. Fuller Company; 81-42.
c. Marathon Industries, Inc.; 130.
d. Mon-Eco Industries, Inc.; 11-30.
e. Vimasco Corporation; 136.
f. Or approved equal.
2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct, equipment, and pipe insulation.
3. Service Temperature Range: Minus 50 to plus 180 deg F (Minus 46 to plus 82 deg C).
4. Color: White.

2.6 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:
1. Products: Subject to compliance with requirements, provide one of the following:
a. Childers Products, Division of ITW; CP-76-8.
b. Foster Products Corporation, H. B. Fuller Company; 95-44.
c. Marathon Industries, Inc.; 405.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

d. Mon-Eco Industries, Inc.; 44-05.
e. Vimasco Corporation; 750.
f. Or approved equal.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
5. Color: Aluminum.

B. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
1. Products: Subject to compliance with requirements, provide one of the following:
a. Childers Products, Division of ITW; CP-76.
b. Or approved equal.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
5. Color: White.

2.7 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
5. PVDC Jacket for Indoor Applications: 4-mil- (0.10-mm-) thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms (0.013 metric perms) when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
a. Products: Subject to compliance with requirements, provide one of the following:
1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.
2) Or approved equal.
6. PVDC Jacket for Outdoor Applications: 6-mil- (0.15-mm-) thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perms (0.007 metric perms) when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.
a. Products: Subject to compliance with requirements, provide one of the following:
1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.
2) Or approved equal.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

7. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.
   a. Products: Subject to compliance with requirements, provide one of the following:
      1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.
      2) Or approved equal.
8. Vinyl Jacket: White vinyl with a permeance of 1.3 perms (0.86 metric perms) when tested according to ASTM E 96, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.8 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Glass-Fiber Fabric for Pipe Insulation: Approximately 2 oz./sq. yd. (68 g/sq. m) with a thread count of 10 strands by 10 strands/sq. inch (4 strands by 4 strands/sq. mm) for covering pipe and pipe fittings.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Vimasco Corporation; Elastafab 894.
      b. Or approved equal.

B. Woven Glass-Fiber Fabric for Duct and Equipment Insulation: Approximately 6 oz./sq. yd. (203 g/sq. m) with a thread count of 5 strands by 5 strands/sq. inch (2 strands by 2 strands/sq. mm) for covering equipment.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Products, Division of ITW; Chil-Glas No. 5.
      b. Or approved equal.

C. Woven Polyester Fabric: Approximately 1 oz./sq. yd. (34 g/sq. m) with a thread count of 10 strands by 10 strands/sq. inch (4 strands by 4 strands/sq. mm), in a Leno weave, for duct, equipment, and pipe.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Foster Products Corporation, H. B. Fuller Company; Mast-A-Fab.
      b. Vimasco Corporation; Elastafab 894.
      c. Or approved equal.

2.9 FIELD-APPLIED CLOTHS

A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd. (271 g/sq. m).
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Alpha Associates, Inc.; Alpha-Maritex 84215 and 84217/9485RW, Luben 59.
      b. Or approved equal.

2.10 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Johns Manville; Zeston.
      b. P.I.C. Plastics, Inc.; FG Series.
      c. Proto PVC Corporation; LoSmoke.
      d. Speedline Corporation; SmokeSafe.
      e. Or approved equal.
   2. Adhesive: As recommended by jacket material manufacturer.
   3. Color: Coordinate with surrounding structure, Owner requirements, or white if not specified.
   4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
      a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.
   5. Factory-fabricated tank heads and tank side panels.

D. Metal Jacket:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Products, Division of ITW; Metal Jacketing Systems.
      b. PABCO Metals Corporation; Surefit.
      c. RPR Products, Inc.; Insul-Mate.
      d. Or approved equal.
   2. Aluminum Jacket: Comply with ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105 or 5005, Temper H-14.
      a. Factory cut and rolled to size.
      b. Finish and thickness are indicated in field-applied jacket schedules.
      c. Moisture Barrier for Indoor Applications: 1-mil- (0.025-mm-) thick, heat-bonded polyethylene and kraft paper.
      d. Moisture Barrier for Outdoor Applications: 2.5-mil- (0.063-mm-) thick Polysurlyn.
      e. Factory-Fabricated Fitting Covers:
         1) Same material, finish, and thickness as jacket.
         2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
         3) Tee covers.
         4) Flange and union covers.
         5) End caps.
         6) Beveled collars.
         7) Valve covers.
         8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.
   3. Stainless-Steel Jacket: ASTM A 167 or ASTM A 240/A 240M.
      a. Factory cut and rolled to size.
      b. Material, finish, and thickness are indicated in field-applied jacket schedules.
      c. Moisture Barrier for Indoor Applications: 1-mil- (0.025-mm-) thick, heat-bonded polyethylene and kraft paper.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

d. Moisture Barrier for Outdoor Applications: 2.5-mil- (0.063-mm-) thick Polysurlyn.
e. Factory-Fabricated Fitting Covers:
   1) Same material, finish, and thickness as jacket.
   2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
   3) Tee covers.
   4) Flange and union covers.
   5) End caps.
   6) Beveled collars.
   7) Valve covers.
   8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

E. Underground Direct-Buried Jacket: 125-mil- (3.2-mm-) thick vapor barrier and waterproofing membrane consisting of a rubberized bituminous resin reinforced with a woven-glass fiber or polyester scrim and laminated aluminum foil.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Pittsburgh Corning Corporation; Pittwrap.
   b. Polyguard; Insulrap No Torch 125.
   c. Or approved equal.

F. Self-Adhesive Outdoor Jacket: 60-mil- (1.5-mm-) thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a crosslaminated polyethylene film covered with white aluminum-foil facing.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Polyguard; Alumaguard 60.
   b. Or approved equal.

G. PVDC Jacket for Indoor Applications: 4-mil- (0.10-mm-) thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms (0.013 metric perms) when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Dow Chemical Company (The), Saran 540 Vapor Retarder Film.
   b. Or approved equal.

H. PVDC Jacket for Outdoor Applications: 6-mil- (0.15-mm-) thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perms (0.007 metric perms) when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Dow Chemical Company (The), Saran 560 Vapor Retarder Film.
   b. Or approved equal.

I. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.
   b. Or approved equal.

2.11 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0835.
      b. Compac Corp.; 104 and 105.
      c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.
      d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
      e. Or approved equal.
   2. Width: 3 inches (75 mm).
   3. Thickness: 11.5 mils (0.29 mm).
   4. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
   5. Elongation: 2 percent.
   6. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
   7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
      b. Compac Corp.; 110 and 111.
      c. Ideal Tape Co., Inc., an American Biltrite Company; 491 AWF FSK.
      d. Venture Tape; 1525 CW, 1528 CW, and 1528 CW/SQ.
      e. Or approved equal.
   2. Width: 3 inches (75 mm).
   3. Thickness: 6.5 mils (0.16 mm).
   4. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
   5. Elongation: 2 percent.
   6. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
   7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0555.
      b. Compac Corp.; 130.
      c. Ideal Tape Co., Inc., an American Biltrite Company; 370 White PVC tape.
      d. Venture Tape; 1506 CW NS.
      e. Or approved equal.
   2. Width: 2 inches (50 mm).
   3. Thickness: 6 mils (0.15 mm).
   4. Adhesion: 64 ounces force/inch (0.7 N/mm) in width.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

5. Elongation: 500 percent.
6. Tensile Strength: 18 lbf/inch (3.3 N/mm) in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
   b. Compac Corp.; 120.
   c. Ideal Tape Co., Inc., an American Biltrite Company; 488 AWF.
   d. Venture Tape; 3520 CW.
   e. Or approved equal.
2. Width: 2 inches (50 mm).
3. Thickness: 3.7 mils (0.093 mm).
4. Adhesion: 100 ounces force/inch (1.1 N/mm) in width.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch (6.2 N/mm) in width.

E. PVDC Tape for Indoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Dow Chemical Company (The); Saran 540 Vapor Retarder Tape.
   b. Or approved equal.
2. Width: 3 inches (75 mm).
3. Film Thickness: 4 mils (0.10 mm).
4. Adhesive Thickness: 1.5 mils (0.04 mm).
5. Elongation at Break: 145 percent.
6. Tensile Strength: 55 lbf/inch (10.1 N/mm) in width.

F. PVDC Tape for Outdoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Dow Chemical Company (The); Saran 560 Vapor Retarder Tape.
   b. Or approved equal.
2. Width: 3 inches (75 mm).
3. Film Thickness: 6 mils (0.15 mm).
4. Adhesive Thickness: 1.5 mils (0.04 mm).
5. Elongation at Break: 145 percent.
6. Tensile Strength: 55 lbf/inch (10.1 N/mm) in width.

2.12 SECUREMENTS

A. Bands:
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Childers Products; Bands.
   b. PABCO Metals Corporation; Bands.
   c. RPR Products, Inc.; Bands.
   d. Or approved equal.
2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch (0.38 mm) thick, 3/4 inch (19 mm) wide with wing or closed seal.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3. Aluminum: ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch (0.51 mm) thick, 3/4 inch (19 mm) wide with wing or closed seal.

B. Insulation Pins and Hangers:
1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated.
   a. Products: Subject to compliance with requirements, provide one of the following:
      1) AGM Industries, Inc.; CWP-1.
      2) GEMCO; CD.
      3) Midwest Fasteners, Inc.; CD.
      4) Nelson Stud Welding; TPA, TPC, and TPS.
      5) Or approved equal.
2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch (38-mm) galvanized carbon-steel washer.
   a. Products: Subject to compliance with requirements, provide one of the following:
      1) AGM Industries, Inc.; CWP-1.
      2) GEMCO; Cupped Head Weld Pin.
      3) Midwest Fasteners, Inc.; Cupped Head.
      4) Nelson Stud Welding; CHP.
      5) Or approved equal.
3. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick, aluminum or stainless-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.
   a. Products: Subject to compliance with requirements, provide one of the following:
      1) AGM Industries, Inc.; RC-150.
      2) GEMCO; R-150.
      3) Midwest Fasteners, Inc.; WA-150.
      4) Nelson Stud Welding; Speed Clips.
      5) Or approved equal.
   b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
4. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.
   a. Products: Subject to compliance with requirements, provide one of the following:
      1) GEMCO.
      2) Midwest Fasteners, Inc.
      3) Or approved equal.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- (19-mm-) wide, stainless steel or Monel.

D. Wire: 0.062-inch (1.6-mm) soft-annealed, stainless steel.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. C & F Wire.
   b. Childers Products.
   c. PABCO Metals Corporation.
   d. RPR Products, Inc.
   e. Or approved equal.

2.13 CORNER ANGLES

A. PVC Corner Angles: 30 mils (0.8 mm) thick, minimum 1 by 1 inch (25 by 25 mm), PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.

B. Aluminum Corner Angles: 0.040 inch (1.0 mm) thick, minimum 1 by 1 inch (25 by 25 mm), aluminum according to ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105 or 5005; Temper H-14.

C. Stainless-Steel Corner Angles: 0.024 inch (0.61 mm) thick, minimum 1 by 1 inch (25 by 25 mm), stainless steel according to ASTM A 167 or ASTM A 240/A 240M, Type 304 or 316.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
1. Verify that systems and equipment to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
   1. Install insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
   3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
   4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:
   1. Draw jacket tight and smooth.
   2. Cover circumferential joints with 3-inch- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches (100 mm) o.c.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches (100 mm) o.c.
   a. For below ambient services, apply vapor-barrier mastic over staples.
4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above ambient services, do not install insulation to the following:
1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches (50 mm) below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
1. Seal penetrations with flashing sealant.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches (50 mm).
4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions. Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches (50 mm).
1. Comply with requirements in Division 07 Section "Penetration Firestopping" and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:
1. Duct: Install insulation continuously through floor penetrations that are not fire rated. For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches (50 mm).
2. Pipe: Install insulation continuously through floor penetrations.
3. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."

3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets,

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.

5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches (50 mm) over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:
1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:
1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.7 MINERAL-FIBER INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:
1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches (150 mm) o.c.
4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Insulation Installation on Pipe Flanges:
   1. Install preformed pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
   4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch (25 mm), and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:
   1. Install preformed sections of same material as straight segments of pipe insulation when available.
   2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:
   1. Install preformed sections of same material as straight segments of pipe insulation when available.
   2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
   3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   4. Install insulation to flanges as specified for flange insulation application.

E. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
   1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
   2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
   3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
      a. On duct sides with dimensions 18 inches (450 mm) and smaller, place pins along longitudinal centerline of duct. Space 3 inches (75 mm) maximum from insulation end joints, and 16 inches (400 mm) o.c.
      b. On duct sides with dimensions larger than 18 inches (450 mm), place pins 16 inches (400 mm) o.c. each way, and 3 inches (75 mm) maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
      c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
      d. Do not overcompress insulation during installation.
      e. Impale insulation over pins and attach speed washers.
      f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches (50 mm) from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch (13-mm) outward-clinching staples, 1 inch (25 mm) o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
   a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
   b. Install vapor stops for ductwork and plenums operating below 50 deg F (10 deg C) at 18-foot (5.5-m) intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches (75 mm).
5. Overlap unfaced blankets a minimum of 2 inches (50 mm) on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches (450 mm) o.c.
6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- (150-mm-) wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches (150 mm) o.c.

F. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
   a. On duct sides with dimensions 18 inches (450 mm) and smaller, place pins along longitudinal centerline of duct. Space 3 inches (75 mm) maximum from insulation end joints, and 16 inches (400 mm) o.c.
   b. On duct sides with dimensions larger than 18 inches (450 mm), space pins 16 inches (400 mm) o.c. each way, and 3 inches (75 mm) maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
   c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
   d. Do not overcompress insulation during installation.
   e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches (50 mm) from 1 edge and 1 end of insulation segment.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

Secure laps to adjacent insulation section with 1/2-inch (13-mm) outward-clinching staples, 1 inch (25 mm) o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.

b. Install vapor stops for ductwork and plenums operating below 50 deg F (10 deg C) at 18-foot (5.5-m) intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches (75 mm).

5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.

6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- (150-mm-) wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches (150 mm) o.c.

3.8 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with 2-inch (50-mm) overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch- (1.6-mm-) thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch (38-mm) laps at longitudinal seams and 3-inch- (75-mm-) wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

C. Where PVC jackets are indicated, install with 1-inch (25-mm) overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

D. Where metal jackets are indicated, install with 2-inch (50-mm) overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches (300 mm) o.c. and at end joints.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

E. Where PVDC jackets are indicated, install as follows:
   1. Apply three separate wraps of filament tape per insulation section to secure pipe insulation to pipe prior to installation of PVDC jacket.
   2. Wrap factory-presized jackets around individual pipe insulation sections with one end overlapping the previously installed sheet. Install presized jacket with an approximate overlap at butt joint of 2 inches (50 mm) over the previous section. Adhere lap seal using adhesive or SSL, and then apply 1-1/4 circumferences of appropriate PVDC tape around overlapped butt joint.
   3. Continuous jacket can be spiral wrapped around a length of pipe insulation. Apply adhesive or PVDC tape at overlapped spiral edge. When electing to use adhesives, refer to manufacturer's written instructions for application of adhesives along this spiral edge to maintain a permanent bond.
   4. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches (850 mm) or less. The 33-1/2-inch- (850-mm-) circumference limit allows for 2-inch- (50-mm-) overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.
   5. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

3.9 FIRE-RATED INSULATION SYSTEM INSTALLATION

A. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.

B. Insulate duct access panels and doors to achieve same fire rating as duct.

C. Install firestopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in Division 07 Section "Penetration Firestopping."

3.10 FINISHES

A. Duct, Equipment, and Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 Sections.
   1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
      a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3.11 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:
1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each duct system defined in the "Duct Insulation Schedule, General" Article.
2. Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.
3. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.12 INDOOR DUCT INSULATION

Service	Thickness	Insulation Type	Vapor barrier	Jacket material
Supply Air, Concealed, Round and Flat Oval	2 inch (50 mm)	Mineral Fiber Blanket, 0.75 lb/cu.ft. (12 kg/cu. m)	Yes	Factory applied FSK aluminum foil with fiberglass reinforced scrim
Outside Air, Concealed, Round and Flat Oval	2 inch (50 mm)	Mineral Fiber Blanket, 0.75 lb/cu.ft. (12 kg/cu. m)	Yes	Factory applied FSK aluminum foil with fiberglass reinforced scrim
Supply Air, Concealed, Rectangular	2 inch (50 mm)	Mineral Fiber Blanket, 0.75 lb/cu.ft. (12 kg/cu. m)	Yes	Factory applied FSK aluminum foil with fiberglass reinforced scrim
Outside Air, Concealed, Rectangular	2 inch (50 mm)	Mineral Fiber Blanket, 0.75 lb/cu.ft. (12 kg/cu. m)	Yes	Factory applied FSK aluminum foil with fiberglass reinforced scrim

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

Service	Thickness	Insulation Type	Vapor barrier	Jacket material
Supply Air, Exposed, Round and Flat Oval	2 inch (50 mm)	Mineral Fiber Blanket, 0.75 lb/cu.ft. (12 kg/cu. m)	Yes	Factory applied FSK aluminum foil with fiberglass reinforced scrim
Outside Air, Exposed, Round and Flat Oval	2 inch (50 mm)	Mineral Fiber Blanket, 0.75 lb/cu.ft. (12 kg/cu. m)	Yes	Factory applied FSK aluminum foil with fiberglass reinforced scrim
Supply Air, Exposed, Rectangular	2 inch (50 mm)	Mineral-Fiber Board, 3-lb/cu.ft. (48 kg/cu. m)	Yes	Factory applied FSK aluminum foil with fiberglass reinforced scrim
Outside Air, Exposed, Rectangular	2 inch (50 mm)	Mineral-Fiber Board, 3-lb/cu.ft. (48 kg/cu. m)	Yes	Factory applied FSK aluminum foil with fiberglass reinforced scrim

3.13 ABOVEGROUND, OUTDOOR DUCT INSULATION

Service	Thickness	Insulation Type	Vapor barrier	Jacket material
Supply Air, Exposed, Round and Flat Oval	3 inch (75 mm)	Mineral Fiber Blanket, 0.75 lb/cu.ft. (12 kg/cu. m)	Yes	Field applied woven glass-fiber or polyester fabric with weatherproof mastic coating
Supply Air, Exposed, Rectangular	3 inch (75 mm)	Mineral Fiber Board, 3-lb/cu.ft. (48 kg/cu. m)	Yes	Field applied woven glass-fiber or polyester fabric with weatherproof mastic coating

3.14 INDOOR PIPING INSULATION

Service	Thickness	Insulation Type	Vapor barrier	Jacket material
Condensate and equipment drain piping below 60 deg F (16 deg C), Exposed or Concealed	Any	3/4 inch (19 mm) Flexible Elastomeric	Yes	None
Refrigerant piping 35 deg F to 50 deg F (2 deg C to 10 deg C), Exposed or Concealed	Suction line-all sizes	1-1/2 inch (38 mm) Flexible Elastomeric	Yes	None

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

Service	Thickness	Insulation Type	Vapor barrier	Jacket material
Refrigerant piping 35 deg F to 50 deg F (2 deg C to 10 deg C), Exposed or Concealed	Hot gas lines-all sizes	3/4 inch (19 mm) Flexible Elastomeric	Yes	None

3.15 OUTDOOR ABOVEGROUND PIPING INSULATION

Service	Thickness	Insulation Type	Vapor barrier	Jacket material
Condensate and equipment drain piping below 60 deg F (16 deg C)	Any	3/4 inch (19 mm) Flexible Elastomeric	Yes	None
Refrigerant piping 35 deg F to 50 deg F (2 deg C to 10 deg C)	Suction line-all sizes	1-1/2 inch (38 mm) Flexible Elastomeric	Yes	None
Refrigerant piping 35 deg F to 50 deg F (2 deg C to 10 deg C)	Hot gas lines-all sizes	3/4 inch (19 mm) Flexible Elastomeric	Yes	None

3.16 OUTDOOR UNDERGROUND PIPING INSULATION

Service	Thickness	Insulation Type	Vapor barrier	Jacket material
Refrigerant piping 35 deg F to 50 deg F (2 deg C to 10 deg C)	Suction line-all sizes	1-1/2 inch (38 mm) Flexible Elastomeric	Yes	Rubberized bituminous resin water-proofing jacket, 125 mil thick (3 mm), reinforced with woven glass fiber or polyester scrim and laminated foil
Refrigerant piping 35 deg F to 50 deg F (2 deg C to 10 deg C)	Hot gas lines-all sizes	3/4 inch (19 mm) Flexible Elastomeric	Yes	Rubberized bituminous resin water-proofing jacket, 125 mil thick (3 mm), reinforced with woven glass fiber or polyester scrim and laminated foil

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

B. Related Sections: Division 33 Section "Gas Lines".

1.2 SUMMARY

A. Section Includes:
1. Pipes, tubes, and fittings.
2. Piping specialties.
3. Piping and tubing joining materials.
4. Valves.
5. Pressure regulators.
6. Service meters.
7. Mechanical sleeve seals.
8. Grout.
9. Concrete bases.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

1.4 PERFORMANCE REQUIREMENTS

A. Minimum Operating-Pressure Ratings:
1. Piping and Valves: 100 psig (690 kPa) minimum unless otherwise indicated.
2. Service Regulators: 65 psig (450 kPa) minimum unless otherwise indicated.

B. Natural-Gas System Pressures within Buildings: Two pressure ranges. Primary pressure is more than 2 psig (13.8 kPa) but not more than 5 psig (34.5 kPa), and is reduced to secondary pressure of more than 0.5 psig (3.45 kPa) but not more than 2 psig (13.8 kPa).

1.5 SUBMITTALS

A. Product Data: For each type of the following:
1. Piping specialties.
2. Corrugated, stainless-steel tubing with associated components.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
4. Pressure regulators. Indicate pressure ratings and capacities.
5. Dielectric fittings.
6. Mechanical sleeve seals.
7. Escutcheons.

B. Shop Drawings: For facility natural-gas piping layout. Include plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure. Detail location of anchors, alignment guides, and expansion joints and loops.
1. Shop Drawing Scale: 1/4 inch per foot (1:50).
2. Detail mounting, supports, and valve arrangements for pressure regulator assembly.

C. Delegated-Design Submittal: For natural-gas piping and equipment indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
1. Detail fabrication and assembly of seismic restraints.
2. Design Calculations: Calculate requirements for selecting seismic restraints.

D. Coordination Drawings: Plans and details, drawn to scale, on which natural-gas piping is shown and coordinated with other installations, using input from installers of the items involved.

E. Site Survey: Plans, drawn to scale, on which natural-gas piping is shown and coordinated with other services and utilities.

F. Field quality-control reports.

G. Operation and Maintenance Data: For motorized gas valves and pressure regulators to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Handling Flammable Liquids: Remove and dispose of liquids from existing natural-gas piping according to requirements of authorities having jurisdiction.

B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.

1.8 PROJECT CONDITIONS

A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.

B. Interruption of Existing Natural-Gas Service: Do not interrupt natural-gas service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide purging and startup of natural-gas supply according to requirements indicated:
   1. Notify Owner no fewer than three days in advance of proposed interruption of natural-gas service.
   2. Do not proceed with interruption of natural-gas service without Owner's written permission.

1.9 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

B. Coordinate requirements for access panels and doors for valves installed concealed behind finished surfaces. Comply with requirements in Division 08 Section "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
   1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
   2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
   3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
   4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
      a. Material Group: 1.1.
      b. End Connections: Threaded or butt welding to match pipe.
      c. Lapped Face: Not permitted underground.
      d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
      e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground.
   5. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.
      a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

6. Mechanical Couplings:
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Dresser Piping Specialties; Division of Dresser, Inc.
      2) Smith-Blair, Inc.
      3) Or approved equal.
   b. Steel flanges and tube with epoxy finish.
   c. Buna-nitrile seals.
   d. Steel bolts, washers, and nuts.
   e. Coupling shall be capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
   f. Steel body couplings installed underground on plastic pipe shall be factory equipped with anode.

B. Corrugated, Stainless-Steel Tubing: Comply with ANSI/IAS LC 1.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. OmegaFlex, Inc.
   b. Parker Hannifin Corporation; Parflex Division.
   c. Titeflex.
   d. Tru-Flex Metal Hose Corp.
   e. Or approved equal.
2. Tubing: ASTM A 240/A 240M, corrugated, Series 300 stainless steel.
3. Coating: PE with flame retardant.
   a. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
      1) Flame-Spread Index: 25 or less.
      2) Smoke-Developed Index: 450 or less.
4. Fittings: Copper-alloy mechanical fittings with ends made to fit and listed for use with corrugated stainless-steel tubing and capable of metal-to-metal seal without gaskets. Include brazing socket or threaded ends complying with ASME B1.20.1.
5. Striker Plates: Steel, designed to protect tubing from penetrations.
6. Manifolds: Malleable iron or steel with factory-applied protective coating. Threaded connections shall comply with ASME B1.20.1 for pipe inlet and corrugated tubing outlets.
7. Operating-Pressure Rating: 5 psig (34.5 kPa).

2.2 PIPING SPECIALTIES

A. Appliance Flexible Connectors:
1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
2. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.
3. Outdoor, Appliance Flexible Connectors: Comply with ANSI Z21.75.
4. Corrugated stainless-steel tubing with polymer coating.
5. Operating-Pressure Rating: 0.5 psig (3.45 kPa).
6. End Fittings: Zinc-coated steel.
7. Threaded Ends: Comply with ASME B1.20.1.
8. Maximum Length: 72 inches (1830 mm).

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Quick-Disconnect Devices: Comply with ANSI Z21.41.
   1. Copper-alloy convenience outlet and matching plug connector.
   2. Nitrile seals.
   3. Hand operated with automatic shutoff when disconnected.
   4. For indoor or outdoor applications.
   5. Adjustable, retractable restraining cable.

C. Y-Pattern Strainers:
   1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
   2. End Connections: Threaded ends for NPS 2 (DN 50) and smaller; flanged ends for NPS 2-1/2 (DN 65) and larger.
   3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
   4. CWP Rating: 125 psig (862 kPa).

D. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

2.3 JOINING MATERIALS

A. Joint Compound and Tape: Suitable for natural gas.

2.4 MANUAL GAS SHUTOFF VALVES

A. See "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles for where each valve type is applied in various services.

B. General Requirements for Metallic Valves, NPS 2 (DN 50) and Smaller: Comply with ASME B16.33.
   1. CWP Rating: 125 psig (862 kPa).
   2. Threaded Ends: Comply with ASME B1.20.1.
   3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
   4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
   5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch (25 mm) and smaller.
   6. Service Mark: Valves 1-1/4 inches (32 mm) to NPS 2 (DN 50) shall have initials "WOG" permanently marked on valve body.

C. General Requirements for Metallic Valves, NPS 2-1/2 (DN 65) and Larger: Comply with ASME B16.38.
   1. CWP Rating: 125 psig (862 kPa).
   2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
   3. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
   4. Service Mark: Initials "WOG" shall be permanently marked on valve body.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

D. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. BrassCraft Manufacturing Company; a Masco company.
      b. Conbraco Industries, Inc.; Apollo Div.
      c. Lyall, R. W. & Company, Inc.
      d. McDonald, A. Y. Mfg. Co.
      e. Perfection Corporation; a subsidiary of American Meter Company.
      f. Or approved equal.
   2. Body: Bronze, complying with ASTM B 584.
   3. Ball: Chrome-plated bronze.
   4. Stem: Bronze; blowout proof.
   5. Seats: Reinforced TFE; blowout proof.
   6. Packing: Threaded-body packnut design with adjustable-stem packing.
   7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
   8. CWP Rating: 600 psig (4140 kPa).
   9. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
   10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

E. Two-Piece, Regular-Port Bronze Ball Valves with Bronze Trim: MSS SP-110.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. BrassCraft Manufacturing Company; a Masco company.
      b. Conbraco Industries, Inc.; Apollo Div.
      c. Lyall, R. W. & Company, Inc.
      d. McDonald, A. Y. Mfg. Co.
      e. Perfection Corporation; a subsidiary of American Meter Company.
      f. Or approved equal.
   2. Body: Bronze, complying with ASTM B 584.
   3. Ball: Chrome-plated bronze.
   4. Stem: Bronze; blowout proof.
   5. Seats: Reinforced TFE.
   6. Packing: Threaded-body packnut design with adjustable-stem packing.
   7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
   8. CWP Rating: 600 psig (4140 kPa).
   9. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
   10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

F. Bronze Plug Valves: MSS SP-78.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Lee Brass Company.
      b. McDonald, A. Y. Mfg. Co.
      c. Or approved equal.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2. Body: Bronze, complying with ASTM B 584.
3. Plug: Bronze.
4. Ends: Threaded, socket, or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
5. Operator: Square head or lug type with tamperproof feature where indicated.
6. Pressure Class: 125 psig (862 kPa).
7. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
8. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

G. Cast-Iron, Nonlubricated Plug Valves: MSS SP-78.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. McDonald, A. Y. Mfg. Co.
   b. Mueller Co.; Gas Products Div.
   c. Xomox Corporation; a Crane company.
   d. Or approved equal.
2. Body: Cast iron, complying with ASTM A 126, Class B.
3. Plug: Bronze or nickel-plated cast iron.
4. Seat: Coated with thermoplastic.
5. Stem Seal: Compatible with natural gas.
6. Ends: Threaded or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
7. Operator: Square head or lug type with tamperproof feature where indicated.
8. Pressure Class: 125 psig (862 kPa).
9. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

H. Cast-Iron, Lubricated Plug Valves: MSS SP-78.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Flowserve.
   b. Homestead Valve; a division of Olson Technologies, Inc.
   c. McDonald, A. Y. Mfg. Co.
   d. Milliken Valve Company.
   e. Mueller Co.; Gas Products Div.
   f. R&M Energy Systems, A Unit of Robbins & Myers, Inc.
   g. Or approved equal.
2. Body: Cast iron, complying with ASTM A 126, Class B.
3. Plug: Bronze or nickel-plated cast iron.
4. Seat: Coated with thermoplastic.
5. Stem Seal: Compatible with natural gas.
6. Ends: Threaded or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
7. Operator: Square head or lug type with tamperproof feature where indicated.
8. Pressure Class: 125 psig (862 kPa).

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

9. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

I. Valve Boxes:
1. Cast-iron, two-section box.
2. Top section with cover with "GAS" lettering.
3. Bottom section with base to fit over valve and barrel a minimum of 5 inches (125 mm) in diameter.
4. Adjustable cast-iron extensions of length required for depth of bury.
5. Include tee-handle, steel operating wrench with socket end fitting valve nut or flat head, and with stem of length required to operate valve.

2.5 PRESSURE REGULATORS

A. General Requirements:
1. Single stage and suitable for natural gas.
2. Steel jacket and corrosion-resistant components.
3. Elevation compensator.
4. End Connections: Threaded for regulators NPS 2 (DN 50) and smaller; flanged for regulators NPS 2-1/2 (DN 65) and larger.

B. Service Pressure Regulators: Comply with ANSI Z21.80.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Actaris.
   b. American Meter Company.
   c. Fisher Control Valves and Regulators; Division of Emerson Process Management.
   d. Invensys.
   e. Richards Industries; Jordan Valve Div.
   f. Or approved equal.
2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
6. Orifice: Aluminum; interchangeable.
7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
10. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
11. Maximum Inlet Pressure: 100 psig (690 kPa).

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

C. Line Pressure Regulators: Comply with ANSI Z21.80.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Actaris.
      b. American Meter Company.
      c. Eclipse Combustion, Inc.
      d. Fisher Control Valves and Regulators; Division of Emerson Process Management.
      e. Invensys.
      f. Maxitrol Company.
      g. Richards Industries; Jordan Valve Div.
      h. Or approved equal.
   2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
   3. Springs: Zinc-plated steel; interchangeable.
   4. Diaphragm Plate: Zinc-plated steel.
   5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
   6. Orifice: Aluminum; interchangeable.
   7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
   8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
   9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
   10. Overpressure Protection Device: Factory mounted on pressure regulator.
   11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
   12. Maximum Inlet Pressure: 10 psig (69 kPa).

D. Appliance Pressure Regulators: Comply with ANSI Z21.18.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Canadian Meter Company Inc.
      b. Eaton Corporation; Controls Div.
      c. Harper Wyman Co.
      d. Maxitrol Company.
      e. SCP, Inc.
      f. Or approved equal.
   2. Body and Diaphragm Case: Die-cast aluminum.
   3. Springs: Zinc-plated steel; interchangeable.
   4. Diaphragm Plate: Zinc-plated steel.
   5. Seat Disc: Nitrile rubber.
   6. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
   7. Factory-Applied Finish: Minimum three-layer polyester and polyurethane paint finish.
   8. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.
   9. Maximum Inlet Pressure: 1 psig (6.9 kPa).

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2.6 DIELECTRIC FITTINGS

A. Dielectric Unions:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Capitol Manufacturing Company.
      b. Central Plastics Company.
      c. Hart Industries International, Inc.
      d. McDonald, A. Y. Mfg. Co.
      e. Watts Regulator Co.; Division of Watts Water Technologies, Inc.
      f. Wilkins; Zurn Plumbing Products Group.
      g. Or approved equal.
   2. Minimum Operating-Pressure Rating: 150 psig (1034 kPa).
   3. Combination fitting of copper alloy and ferrous materials.
   4. Insulating materials suitable for natural gas.
   5. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.

B. Dielectric Flanges:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Capitol Manufacturing Company.
      b. Central Plastics Company.
      c. Watts Regulator Co.; Division of Watts Water Technologies, Inc.
      d. Wilkins; Zurn Plumbing Products Group.
      e. Or approved equal.
   2. Minimum Operating-Pressure Rating: 150 psig (1034 kPa).
   3. Combination fitting of copper alloy and ferrous materials.
   4. Insulating materials suitable for natural gas.
   5. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.

C. Dielectric-Flange Kits:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Advance Products & Systems, Inc.
      b. Calpico Inc.
      c. Central Plastics Company.
      d. Pipeline Seal and Insulator, Inc.
      e. Or approved equal.
   2. Minimum Operating-Pressure Rating: 150 psig (1034 kPa).
   3. Companion-flange assembly for field assembly.
   4. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or PE bolt sleeves, phenolic washers, and steel backing washers.
   5. Insulating materials suitable for natural gas.
   6. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2.7 SLEEVES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

2.8 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Advance Products & Systems, Inc.
      b. Calpico Inc.
      c. Metraflex Company (The).
      d. Pipeline Seal and Insulator, Inc.
      e. Or approved equal.
   2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe and sleeve.
   3. Pressure Plates: Stainless steel.
   4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one nut and bolt for each sealing element.

2.9 ESCUTCHEONS

A. General Requirements for Escutcheons: Manufactured wall and ceiling escutcheons and floor plates, with ID to fit around pipe or tube, and OD that completely covers opening.

B. One-Piece, Deep-Pattern Escutcheons: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Cast-Brass Escutcheons: With set screw.
   1. Finish: Polished chrome-plated.

D. Split-Casting, Cast-Brass Escutcheons: With concealed hinge and set screw.
   1. Finish: Polished chrome-plated.

E. One-Piece, Floor-Plate Escutcheons: Cast-iron floor plate.

F. Split-Casting, Floor-Plate Escutcheons: Cast brass with concealed hinge and set screw.

2.10 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1. Characteristics: Post-hardening, volume adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

2.11 LABELING AND IDENTIFYING

A. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches (750 mm) deep; colored yellow.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Close equipment shutoff valves before turning off natural gas to premises or piping section.

B. Inspect natural-gas piping according to NFPA 54 to determine that natural-gas utilization devices are turned off in piping section affected.

C. Comply with NFPA 54 requirements for prevention of accidental ignition.

3.3 INDOOR PIPING INSTALLATION

A. Comply with NFPA 54 for installation and purging of natural-gas piping.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.

D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

G. Locate valves for easy access.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Install escutcheons at penetrations of interior walls, ceilings, and floors.
   1. New Piping:
      a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
      b. Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
      c. Piping at Ceiling Penetrations in Finished Spaces: One-piece or split-casting, cast-brass type with polished chrome-plated finish.
      d. Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished chrome-plated finish.
      e. Piping in Equipment Rooms: One-piece, cast-brass type.
      f. Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
   2. Existing Piping:
      a. Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.
      b. Piping at Ceiling Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.
      c. Piping in Unfinished Service Spaces: Split-casting, cast-brass type with polished chrome-plated finish.
      d. Piping in Equipment Rooms: Split-casting, cast-brass type.
      e. Piping at Floor Penetrations in Equipment Rooms: Split-casting, floor-plate type.

K. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements in Division 07 Sections.

L. Verify final equipment locations for roughing-in.

M. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.

N. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.
   1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches (75 mm) long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

O. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.

P. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.

Q. Concealed Location Installations: Except as specified below, install concealed natural-gas piping and piping installed under the building in containment conduit constructed of steel pipe with welded joints as described in Part 2. Install a vent pipe from containment conduit to outdoors and terminate with weatherproof vent cap.
   1. Above Accessible Ceilings: Natural-gas piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.
   2. In Floors: Install natural-gas piping with welded or brazed joints and protective coating in cast-in-place concrete floors. Cover piping to be cast in concrete slabs with minimum of 1-1/2 inches (38 mm) of concrete. Piping may not be in physical contact with other metallic structures such as reinforcing rods or electrically neutral conductors. Do not embed piping in concrete slabs containing quick-set additives or cinder aggregate.
   3. In Floor Channels: Install natural-gas piping in floor channels. Channels must have cover and be open to space above cover for ventilation.
   4. In Walls or Partitions: Protect tubing installed inside partitions or hollow walls from physical damage using steel striker barriers at rigid supports.
      a. Exception: Tubing passing through partitions or walls does not require striker barriers.
   5. Prohibited Locations:
      a. Do not install natural-gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
      b. Do not install natural-gas piping in solid walls or partitions.

R. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

S. Connect branch piping from top or side of horizontal piping.

T. Install unions in pipes NPS 2 (DN 50) and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.

U. Do not use natural-gas piping as grounding electrode.

V. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.

W. Install pressure gage upstream and downstream from each line regulator. Pressure gages are specified in Division 23.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3.4 VALVE INSTALLATION

A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing, aluminum, or copper connector.

B. Install underground valves with valve boxes.

C. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.

D. Install earthquake valves aboveground outside buildings according to listing.

E. Install anode for metallic valves in underground PE piping.

3.5 PIPING JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints:
1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
2. Cut threads full and clean using sharp dies.
3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Welded Joints:
1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
2. Bevel plain ends of steel pipe.
3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.

F. Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.

G. Flared Joints: Cut tubing with roll cutting tool. Flare tube end with tool to result in flare dimensions complying with SAE J513. Tighten finger tight, then use wrench. Do not overtighten.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

H. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
   1. Plain-End Pipe and Fittings: Use butt fusion.
   2. Plain-End Pipe and Socket Fittings: Use socket fusion.

3.6 HANGER AND SUPPORT INSTALLATION

A. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

B. Comply with requirements for pipe hangers and supports specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

C. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:
   1. NPS 1 (DN 25) and Smaller: Maximum span, 96 inches (2438 mm); minimum rod size, 3/8 inch (10 mm).
   2. NPS 1-1/4 (DN 32): Maximum span, 108 inches (2743 mm); minimum rod size, 3/8 inch (10 mm).
   3. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): Maximum span, 108 inches (2743 mm); minimum rod size, 3/8 inch (10 mm).
   4. NPS 2-1/2 to NPS 3-1/2 (DN 65 to DN 90): Maximum span, 10 feet (3 m); minimum rod size, 1/2 inch (13 mm).
   5. NPS 4 (DN 100) and Larger: Maximum span, 10 feet (3 m); minimum rod size, 5/8 inch (15.8 mm).

D. Install hangers for horizontal drawn-temper copper tubing with the following maximum spacing and minimum rod sizes:
   1. NPS 3/8 (DN 10): Maximum span, 48 inches (1220 mm); minimum rod size, 3/8 inch (10 mm).
   2. NPS 1/2 and NPS 5/8 (DN 15 and DN 18): Maximum span, 72 inches (1830 mm); minimum rod size, 3/8 inch (10 mm).
   3. NPS 3/4 and NPS 7/8 (DN 20 and DN 22): Maximum span, 84 inches (2134 mm); minimum rod size, 3/8 inch (10 mm).
   4. NPS 1 (DN 25): Maximum span, 96 inches (2440 mm); minimum rod size, 3/8 inch (10 mm).

E. Install hangers for horizontal, corrugated stainless-steel tubing with the following maximum spacing and minimum rod sizes:
   1. NPS 3/8 (DN 10): Maximum span, 48 inches (1220 mm); minimum rod size, 3/8 inch (10 mm).
   2. NPS 1/2 (DN 15): Maximum span, 72 inches (1830 mm); minimum rod size, 3/8 inch (10 mm).
   3. NPS 3/4 (DN 20) and Larger: Maximum span, 96 inches (2440 mm); minimum rod size, 3/8 inch (10 mm).

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3.7 CONNECTIONS

A. Install piping adjacent to appliances to allow service and maintenance of appliances.

B. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches (1800 mm) of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.

C. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.8 LABELING AND IDENTIFYING

A. Comply with requirements in Division 23 Section "Identification for HVAC Piping and Equipment" for piping and valve identification.

3.9 PAINTING

A. Comply with requirements in Division 09 painting Sections for painting interior and exterior natural-gas piping.

B. Paint exposed, interior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.
   1. Alkyd System: MPI INT 5.1E.
      a. Prime Coat: Alkyd anticorrosive metal primer.
      b. Intermediate Coat: Interior alkyd matching topcoat.
      c. Topcoat: Interior alkyd (semigloss).
      d. Color: Match existing Owner standards.

C. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.10 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to seismic codes at Project.
   1. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit.
   2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of the base.
   3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
   4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   5. Install anchor bolts to elevations required for proper attachment to supported equipment.
   6. Use 3000-psig (20.7-MPa), 28-day, compressive-strength concrete and reinforcement.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3.11 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:
   1. Test, inspect, and purge natural gas according to NFPA 54 and authorities having jurisdiction.

C. Natural-gas piping will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.12 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES LESS THAN 0.5 PSIG (3.45 kPa)

A. Aboveground, branch piping NPS 1 (DN 25) and smaller shall be one of the following:
   1. Aluminum tube with flared fittings and joints.
   2. Steel pipe with malleable-iron fittings and threaded joints.

B. Aboveground, distribution piping shall be one of the following:
   1. Steel pipe with malleable-iron fittings and threaded joints.
   2. Steel pipe with wrought-steel fittings and welded joints.

C. Underground, below building, piping shall be one of the following:
   1. Steel pipe with malleable-iron fittings and threaded joints.
   2. Steel pipe with wrought-steel fittings and welded joints.

D. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

E. Containment Conduit Vent Piping: Steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground pipe and fittings with protective coating for steel piping.

3.13 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES MORE THAN 0.5 PSIG (3.45 kPa) AND LESS THAN 5 PSIG (34.5 kPa)

A. Aboveground, branch piping NPS 1 (DN 25) and smaller shall be one of the following:
   1. Aluminum tube with flared fittings and joints.
   2. Steel pipe with malleable-iron fittings and threaded joints.

B. Aboveground, distribution piping shall be one of the following:
   1. Steel pipe with malleable-iron fittings and threaded joints.
   2. Steel pipe with steel welding fittings and welded joints.

C. Underground, below building, piping shall be one of the following:
   1. Steel pipe with malleable-iron fittings and threaded joints.
   2. Steel pipe with wrought-steel fittings and welded joints.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

D. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat underground pipe and fittings with protective coating for steel piping.

E. Containment Conduit Vent Piping: Steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground pipe and fittings with protective coating for steel piping.

3.14 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES MORE THAN 5 PSIG (34.5 kPa)

A. Aboveground Piping: Maximum operating pressure more than 5 psig (34.5 kPa).

B. Aboveground, Branch Piping: Steel pipe with steel welding fittings and welded joints.

C. Aboveground, distribution piping shall be the following:
1. Steel pipe with steel welding fittings and welded joints.

D. Underground, below building, piping shall be one of the following:
1. Steel pipe with malleable-iron fittings and threaded joints.
2. Steel pipe with wrought-steel fittings and welded joints.

E. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

F. Containment Conduit Vent Piping: Steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground pipe and fittings with protective coating for steel piping.

3.15 UNDERGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Connections to Existing Gas Piping: Use valve and fitting assemblies made for tapping utility's gas mains and listed by an NRTL.

3.16 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Valves for pipe sizes NPS 2 (DN 50) and smaller at service meter shall be one of the following:
1. One-piece, bronze ball valve with bronze trim.
2. Two-piece, full-port, bronze ball valves with bronze trim.
3. Bronze plug valve.

B. Valves for pipe sizes NPS 2-1/2 (DN 65) and larger at service meter shall be one of the following:
1. Two-piece, full-port, bronze ball valves with bronze trim.
2. Bronze plug valve.
3. Cast-iron, nonlubricated plug valve.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

C. Distribution piping valves for pipe sizes NPS 2 (DN 50) and smaller shall be one of the following:
   1. One-piece, bronze ball valve with bronze trim.
   2. Two-piece, full-port, bronze ball valves with bronze trim.
   3. Bronze plug valve.

D. Distribution piping valves for pipe sizes NPS 2-1/2 (DN 65) and larger shall be one of the following:
   1. Two-piece, full-port, bronze ball valves with bronze trim.
   2. Bronze plug valve.
   3. Cast-iron, nonlubricated plug valve.

E. Valves in branch piping for single appliance shall be one of the following:
   1. One-piece, bronze ball valve with bronze trim.
   2. Two-piece, full-port, bronze ball valves with bronze trim.
   3. Bronze plug valve.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes refrigerant piping used for air-conditioning applications.

1.3 PERFORMANCE REQUIREMENTS

A. Line Test Pressure for Refrigerant R-22:
   1. Suction Lines for Air-Conditioning Applications: 185 psig (1276 kPa).
   2. Suction Lines for Heat-Pump Applications: 325 psig (2241 kPa).
   3. Hot-Gas and Liquid Lines: 325 psig (2241 kPa).

B. Line Test Pressure for Refrigerant R-410A:
   1. Suction Lines for Air-Conditioning Applications: 300 psig (2068 kPa).
   2. Suction Lines for Heat-Pump Applications: 535 psig (3689 kPa).
   3. Hot-Gas and Liquid Lines: 535 psig (3689 kPa).

1.4 SUBMITTALS

A. Product Data: For each type of valve and refrigerant piping specialty indicated. Include pressure drop, based on manufacturer's test data, for the following:
   1. Thermostatic expansion valves.
   2. Solenoid valves.
   3. Hot-gas bypass valves.
   4. Filter dryers.
   5. Strainers.
   6. Pressure-regulating valves.

B. Shop Drawings: Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes, flow capacities, valve arrangements and locations, slopes of horizontal runs, oil traps, double risers, wall and floor penetrations, and equipment connection details. Show interface and spatial relationships between piping and equipment.
   1. Shop Drawing Scale: 1/4 inch equals 1 foot (1:50).
   2. Refrigerant piping indicated on Drawings is schematic only. Size piping and design actual piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.

C. Welding certificates.

D. Field quality-control test reports.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

E. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

B. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."

C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.6 PRODUCT STORAGE AND HANDLING

A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

1.7 COORDINATION

A. Coordinate size and location of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Copper Tube: ASTM B 88, Type K (ASTM B 88M, Type A).

B. Wrought-Copper Fittings: ASME B16.22.

C. Wrought-Copper Unions: ASME B16.22.

D. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.

E. Brazing Filler Metals: AWS A5.8.

F. Flexible Connectors:
1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
2. End Connections: Socket ends.
3. Offset Performance: Capable of minimum 3/4-inch (20-mm) misalignment in minimum 7-inch- (180-mm-) long assembly.
4. Pressure Rating: Factory test at minimum 500 psig (3450 kPa).
5. Maximum Operating Temperature: 250 deg F (121 deg C).

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2.2 VALVES AND SPECIALTIES

A. Diaphragm Packless Valves:
1. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
2. Diaphragm: Phosphor bronze and stainless steel with stainless-steel spring.
3. Operator: Rising stem and hand wheel.
4. Seat: Nylon.
5. End Connections: Socket, union, or flanged.
6. Working Pressure Rating: 500 psig (3450 kPa).
7. Maximum Operating Temperature: 275 deg F (135 deg C).

B. Packed-Angle Valves:
1. Body and Bonnet: Forged brass or cast bronze.
2. Packing: Molded stem, back seating, and replaceable under pressure.
3. Operator: Rising stem.
4. Seat: Nonrotating, self-aligning polytetrafluoroethylene.
5. Seal Cap: Forged-brass or valox hex cap.
6. End Connections: Socket, union, threaded, or flanged.
7. Working Pressure Rating: 500 psig (3450 kPa).
8. Maximum Operating Temperature: 275 deg F (135 deg C).

C. Check Valves:
1. Body: Ductile iron, forged brass, or cast bronze; globe pattern.
2. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.
3. Piston: Removable polytetrafluoroethylene seat.
4. Closing Spring: Stainless steel.
5. End Connections: Socket, union, threaded, or flanged.
6. Maximum Opening Pressure: 0.50 psig (3.4 kPa).
7. Working Pressure Rating: 500 psig (3450 kPa).
8. Maximum Operating Temperature: 275 deg F (135 deg C).

D. Service Valves:
1. Body: Forged brass with brass cap including key end to remove core.
2. Core: Removable ball-type check valve with stainless-steel spring.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Copper spring.
5. Working Pressure Rating: 500 psig (3450 kPa).

E. Solenoid Valves: Comply with ARI 760 and UL 429; listed and labeled by an NRTL.
1. Body and Bonnet: Plated steel.
2. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Threaded.
5. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch (16-GRC) conduit adapter, and 24-V ac coil.
6. Working Pressure Rating: 400 psig (2760 kPa).
7. Maximum Operating Temperature: 240 deg F (116 deg C).

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

F. Safety Relief Valves: Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
   1. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
   2. Piston, Closing Spring, and Seat Insert: Stainless steel.
   3. Seat Disc: Polytetrafluoroethylene.
   4. End Connections: Threaded.
   5. Working Pressure Rating: 400 psig (2760 kPa).
   6. Maximum Operating Temperature: 240 deg F (116 deg C).

G. Thermostatic Expansion Valves: Comply with ARI 750.
   1. Body, Bonnet, and Seal Cap: Forged brass or steel.
   2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
   3. Packing and Gaskets: Non-asbestos.
   4. Capillary and Bulb: Copper tubing filled with refrigerant charge.
   5. Superheat: Adjustable
   6. Reverse-flow option (for heat-pump applications).
   7. End Connections: Socket, flare, or threaded union.
   8. Working Pressure Rating: 450 psig (3100 kPa).

H. Hot-Gas Bypass Valves: Comply with UL 429; listed and labeled by an NRTL.
   1. Body, Bonnet, and Seal Cap: Ductile iron or steel.
   2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
   3. Packing and Gaskets: Non-asbestos.
   4. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
   5. Seat: Polytetrafluoroethylene.
   6. Equalizer: External.
   7. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch (16-GRC) conduit adapter, and 24-V ac coil.
   8. End Connections: Socket.
   9. Throttling Range: Maximum 5 psig (34 kPa).
   10. Working Pressure Rating: 500 psig (3450 kPa).
   11. Maximum Operating Temperature: 240 deg F (116 deg C).

I. Straight-Type Strainers:
   1. Body: Welded steel with corrosion-resistant coating.
   2. Screen: 100-mesh stainless steel.
   3. End Connections: Socket or flare.
   4. Working Pressure Rating: 500 psig (3450 kPa).
   5. Maximum Operating Temperature: 275 deg F (135 deg C).

J. Angle-Type Strainers:
   1. Body: Forged brass or cast bronze.
   2. Drain Plug: Brass hex plug.
   3. Screen: 100-mesh monel.
   4. End Connections: Socket or flare.
   5. Working Pressure Rating: 500 psig (3450 kPa).
   6. Maximum Operating Temperature: 275 deg F (135 deg C).

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

K. Moisture/Liquid Indicators:
1. Body: Forged brass.
2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
3. Indicator: Color coded to show moisture content in ppm.
4. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
5. End Connections: Socket or flare.
6. Working Pressure Rating: 500 psig (3450 kPa).
7. Maximum Operating Temperature: 240 deg F (116 deg C).

L. Replaceable-Core Filter Dryers: Comply with ARI 730.
1. Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.
2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
3. Desiccant Media: Activated alumina.
4. Designed for reverse flow (for heat-pump applications).
5. End Connections: Socket.
6. Access Ports: NPS 1/4 (DN 8) connections at entering and leaving sides for pressure differential measurement.
7. Maximum Pressure Loss: 2 psig (14 kPa).
8. Working Pressure Rating: 500 psig (3450 kPa).
9. Maximum Operating Temperature: 240 deg F (116 deg C).

M. Permanent Filter Dryers: Comply with ARI 730.
1. Body and Cover: Painted-steel shell.
2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
3. Desiccant Media: Activated alumina.
4. Designed for reverse flow (for heat-pump applications).
5. End Connections: Socket.
6. Access Ports: NPS 1/4 (DN 8) connections at entering and leaving sides for pressure differential measurement.
7. Maximum Pressure Loss: 2 psig (14 kPa).
8. Working Pressure Rating: 500 psig (3450 kPa).
9. Maximum Operating Temperature: 240 deg F (116 deg C).

N. Mufflers:
1. Body: Welded steel with corrosion-resistant coating.
2. End Connections: Socket or flare.
3. Working Pressure Rating: 500 psig (3450 kPa).
4. Maximum Operating Temperature: 275 deg F (135 deg C).

O. Receivers: Comply with ARI 495.
1. Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
2. Comply with UL 207; listed and labeled by an NRTL.
3. Body: Welded steel with corrosion-resistant coating.
4. Tappings: Inlet, outlet, liquid level indicator, and safety relief valve.
5. End Connections: Socket or threaded.
6. Working Pressure Rating: 500 psig (3450 kPa).
7. Maximum Operating Temperature: 275 deg F (135 deg C).

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

P. Liquid Accumulators: Comply with ARI 495.
   1. Body: Welded steel with corrosion-resistant coating.
   2. End Connections: Socket or threaded.
   3. Working Pressure Rating: 500 psig (3450 kPa).
   4. Maximum Operating Temperature: 275 deg F (135 deg C).

2.3 REFRIGERANTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Atofina Chemicals, Inc.
   2. DuPont Company; Fluorochemicals Div.
   3. Honeywell, Inc.; Genetron Refrigerants.
   4. INEOS Fluor Americas LLC.
   5. Or approved equal.

B. ASHRAE 34, R-22: Monochlorodifluoromethane.

C. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS FOR REFRIGERANT R-22

A. Suction Lines NPS 4 (DN 100) and Smaller for Conventional Air-Conditioning Applications: Copper, Type K (A), drawn-temper tubing and wrought-copper fittings with brazed joints.

B. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications: Copper, Type K (A), drawn-temper tubing and wrought-copper fittings with soldered joints.

C. Safety-Relief-Valve Discharge Piping: Copper, Type K (A), drawn-temper tubing and wrought-copper fittings with soldered joints.

3.2 PIPING APPLICATIONS FOR REFRIGERANT R-410A

A. Suction Lines NPS 4 (DN 100) and Smaller for Conventional Air-Conditioning Applications: Copper, Type K (A), drawn-temper tubing and wrought-copper fittings with brazed joints.

B. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications: Copper, Type K (A), annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.

C. Safety-Relief-Valve Discharge Piping: Copper, Type K (A), drawn-temper tubing and wrought-copper fittings with Alloy HB soldered joints.

3.3 VALVE AND SPECIALTY APPLICATIONS

A. Install diaphragm packless or packed-angle valves in suction and discharge lines of compressor.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Install service valves for gage taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.

C. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.

D. Except as otherwise indicated, install diaphragm packless or packed-angle valves on inlet and outlet side of filter dryers.

E. Install a full-sized, three-valve bypass around filter dryers.

F. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top.

G. Install thermostatic expansion valves as close as possible to distributors on evaporators.
   1. Install valve so diaphragm case is warmer than bulb.
   2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
   3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.

H. Install safety relief valves where required by ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.

I. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.

J. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for device being protected:
   1. Solenoid valves.
   2. Thermostatic expansion valves.
   3. Hot-gas bypass valves.
   4. Compressor.

K. Install filter dryers in liquid line between compressor and thermostatic expansion valve.

L. Install receivers sized to accommodate pump-down charge.

M. Install flexible connectors at compressors.

3.4 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.

B. Install refrigerant piping according to ASHRAE 15.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping adjacent to machines to allow service and maintenance.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Select system components with pressure rating equal to or greater than system operating pressure.

J. Refer to Division 23 for solenoid valve controllers, control wiring, and sequence of operation.

K. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

L. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Division 08 if valves or equipment requiring maintenance is concealed behind finished surfaces.

M. Install refrigerant piping in protective conduit where installed belowground.

N. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

O. Slope refrigerant piping as follows:
   1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
   2. Install horizontal suction lines with a uniform slope downward to compressor.
   3. Install traps and double risers to entrain oil in vertical runs.
   4. Liquid lines may be installed level.

P. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.

Q. Install pipe sleeves at penetrations in exterior walls and floor assemblies.

R. Seal penetrations through fire and smoke barriers according to Division 07.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

S. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

T. Install sleeves through floors, walls, or ceilings, sized to permit installation of full-thickness insulation.

U. Seal pipe penetrations through exterior walls according to Division 07 Section "Joint Sealants" for materials and methods.

V. Identify refrigerant piping and valves according to Division 23 Section "Identification for HVAC Piping and Equipment."

3.5 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."

D. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
   1. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.
   2. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.

E. Threaded Joints: Thread steel pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads unless dry-seal threading is specified.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

F. Welded Joints: Construct joints according to AWS D10.12/D10.12M.

G. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.6 HANGERS AND SUPPORTS

A. Hanger, support, and anchor products are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

B. Install the following pipe attachments:
   1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet (6 m) long.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2. Roller hangers and spring hangers for individual horizontal runs 20 feet (6 m) or longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet (6 m) or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.
5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

C. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:
1. NPS 1/2 (DN 15): Maximum span, 60 inches (1500 mm); minimum rod size, 1/4 inch (6.4 mm).
2. NPS 5/8 (DN 18): Maximum span, 60 inches (1500 mm); minimum rod size, 1/4 inch (6.4 mm).
3. NPS 1 (DN 25): Maximum span, 72 inches (1800 mm); minimum rod size, 1/4 inch (6.4 mm).
4. NPS 1-1/4 (DN 32): Maximum span, 96 inches (2400 mm); minimum rod size, 3/8 inch (9.5 mm).
5. NPS 1-1/2 (DN 40): Maximum span, 96 inches (2400 mm); minimum rod size, 3/8 inch (9.5 mm).
6. NPS 2 (DN 50): Maximum span, 96 inches (2400 mm); minimum rod size, 3/8 inch (9.5 mm).
7. NPS 2-1/2 (DN 65): Maximum span, 108 inches (2700 mm); minimum rod size, 3/8 inch (9.5 mm).
8. NPS 3 (DN 80): Maximum span, 10 feet (3 m); minimum rod size, 3/8 inch (9.5 mm).
9. NPS 4 (DN 100): Maximum span, 12 feet (3.7 m); minimum rod size, 1/2 inch (13 mm).

D. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:
1. NPS 2 (DN 50): Maximum span, 10 feet (3 m); minimum rod size, 3/8 inch (9.5 mm).
2. NPS 2-1/2 (DN 65): Maximum span, 11 feet (3.4 m); minimum rod size, 3/8 inch (9.5 mm).
3. NPS 3 (DN 80): Maximum span, 12 feet (3.7 m); minimum rod size, 3/8 inch (9.5 mm).
4. NPS 4 (DN 100): Maximum span, 14 feet (4.3 m); minimum rod size, 1/2 inch (13 mm).

E. Support multifloor vertical runs at least at each floor.

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:
1. Comply with ASME B31.5, Chapter VI.
2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in Part 1 "Performance Requirements" Article.
   a. Fill system with nitrogen to the required test pressure.
   b. System shall maintain test pressure at the manifold gage throughout duration of test.
   c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
   d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

3.8 SYSTEM CHARGING

A. Charge system using the following procedures:
   1. Install core in filter dryers after leak test but before evacuation.
   2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers (67 Pa). If vacuum holds for 12 hours, system is ready for charging.
   3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig (14 kPa).
   4. Charge system with a new filter-dryer core in charging line.

3.9 ADJUSTING

A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.

B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.

C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.

D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
   1. Open shutoff valves in condenser water circuit.
   2. Verify that compressor oil level is correct.
   3. Open compressor suction and discharge valves.
   4. Open refrigerant valves except bypass valves that are used for other purposes.
   5. Check open compressor-motor alignment and verify lubrication for motors and bearings.

E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
1. Single-wall rectangular ducts and fittings.
2. Single-wall round ducts and fittings.
3. Sheet metal materials.
4. Sealants and gaskets.
5. Hangers and supports.
6. Seismic-restraint devices.

B. Related Sections:
1. Division 09 Section "Protective Coatings".
2. Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
3. Division 23 Section "Nonmetal Ducts" for fibrous-glass ducts, thermoset fiber-reinforced plastic ducts, thermoplastic ducts, PVC ducts, and concrete ducts.
4. Division 23 Section "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.3 SYSTEM DESCRIPTION

A. Duct system design, as indicated, has been used to select size and type of air-moving and distribution equipment and other air system components. Changes to layout or configuration of duct system must be specifically approved in writing by Architect. Accompany requests for layout modifications with calculations showing that proposed layout will provide original design results without increasing system total pressure.

B. Dimensions indicated on drawings are inside clear dimensions. Where internal duct liner or double wall construction is used, Contractor shall increase duct dimensions as required to maintain inside clear dimensions. The first dimension given indicates that side shown on both plan and section.

1.4 PERFORMANCE REQUIREMENTS

A. Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated.
1. Static-Pressure Classes:
a. Low Pressure Supply Ducts (except in Mechanical Rooms): 2-inch wg (500 Pa).
b. Supply Ducts (Upstream from Air Terminal Units): 4-inch wg (1000 Pa).
c. Supply Ducts (Downstream from Air Terminal Units): 1-inch wg (250 Pa).

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

d. Supply Ducts (in Mechanical Equipment Rooms): 4-inch wg (1000 Pa).
e. Return Ducts (Negative Pressure): 2-inch wg (500 Pa).
f. Exhaust Ducts (Negative Pressure): 2-inch wg (500 Pa).

2. Leakage Class:
   a. Supply Air Ducts: 1 percent of design airflow at maximum duct design static pressure.
   b. Return Air Ducts: 2 percent of design airflow at maximum duct design static pressure.
   c. Exhaust Air Ducts: 2 percent of design airflow at maximum duct design static pressure.

B. Structural Performance: Duct hangers and supports shall withstand the effects of gravity and seismic loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems" as required by local codes.

1.5 SUBMITTALS

A. Product Data: For each type of the following products:
1. Liners and adhesives.
2. Sealants and gaskets.
3. Seismic-restraint devices.

B. Shop Drawings:
1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Factory- and shop-fabricated ducts and fittings.
3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
4. Elevation of top of ducts.
5. Dimensions of main duct runs from building grid lines.
6. Fittings.
7. Reinforcement and spacing.
8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment, seismic restraints, and vibration isolation.

C. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
2. Suspended ceiling components.
3. Structural members to which duct will be attached.
4. Size and location of initial access modules for acoustical tile.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

5. Penetrations of smoke barriers and fire-rated construction.
6. Items penetrating finished ceiling including the following:
   a. Lighting fixtures.
   b. Air outlets and inlets.
   c. Access panels.
   d. Perimeter moldings.

D. Welding certificates.

E. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

B. Welding Qualifications: Qualify procedures and personnel according to the following:
1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.
3. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-4, "Transverse (Girth) Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-5, "Longitudinal Seams - Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Shall be as indicated on drawings and fabricated according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 2, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1. For mitered 90 degree ells, use single thickness turning vanes.
2. On medium pressure ducts, use high efficiency turning vanes with a minimum 1 inch (25mm) trailing edge.

2.2 DOUBLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. McGill AirFlow LLC.
2. Lindab.
3. Or approved equal.

B. Rectangular Ducts: Fabricate ducts with indicated dimensions for the inner duct.

C. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

D. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-4, "Transverse (Girth) Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

E. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-5, "Longitudinal Seams - Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

F. Formed-on Transverse Joints (Flanges): Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-4, "Traverse (Girth) Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

G. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-5, "Longitudinal Seams - Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
   1. Galvanized Coating Designation: G90 (Z275).
   2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. PVC-Coated, Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
   1. Galvanized Coating Designation: G90 (Z275).
   2. Minimum Thickness for Factory-Applied PVC Coating: 4 mils (0.10 mm) thick on sheet metal surface of ducts and fittings exposed to corrosive conditions, and minimum 1 mil (0.025 mm) thick on opposite surface.
   3. Coating Materials: Acceptable to authorities having jurisdiction for use on ducts listed and labeled by an NRTL for compliance with UL 181, Class 1.

D. Carbon-Steel Sheets: Comply with ASTM A 1008/A 1008M, with oiled, matte finish for exposed ducts.

E. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2D for concealed duct, and No. 3D for exposed ducts.

F. Aluminum Sheets: Comply with ASTM B 209 (ASTM B 209M) Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.

G. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
   1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

H. Tie Rods: Galvanized steel, 1/4-inch (6-mm) minimum diameter for lengths 36 inches (900 mm) or less; 3/8-inch (10-mm) minimum diameter for lengths longer than 36 inches (900 mm).

2.4 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Two-Part Tape Sealing System:
   1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
   2. Tape Width: 4 inches (102 mm).
   3. Sealant: Modified styrene acrylic.
   4. Water resistant.
   5. Mold and mildew resistant.
   6. Maximum Static-Pressure Class: 10-inch wg (2500 Pa), positive and negative.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

7. Service: Indoor and outdoor.
8. Service Temperature: Minus 40 to plus 200 deg F (Minus 40 to plus 93 deg C).
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.

C. Water-Based Joint and Seam Sealant:
1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10-inch wg (2500 Pa), positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

D. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

E. Round Duct Joint O-Ring Seals:
1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg (0.14 L/s per sq. m at 250 Pa) and shall be rated for 10-inch wg (2500-Pa) static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.5 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1 (Table 4-1M), "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.

F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

H. Trapeze and Riser Supports:
   1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
   2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
   3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

2.6 SEISMIC-RESTRAINT DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cooper B-Line, Inc.; a division of Cooper Industries.
   2. Ductmate Industries, Inc.
   3. Hilti Corp.
   4. Kinetics Noise Control.
   5. Loos & Co.; Cableware Division.
   6. Mason Industries.
   7. TOLCO; a brand of NIBCO INC.
   8. Unistrut Corporation; Tyco International, Ltd.
   9. Or approved equal.

B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an agency acceptable to authorities having jurisdiction.
   1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.

C. Channel Support System: Shop- or field-fabricated support assembly made of slotted steel channels rated in tension, compression, and torsion forces and with accessories for attachment to braced component at one end and to building structure at the other end. Include matching components and corrosion-resistant coating.

D. Restraint Cables: ASTM A 603, galvanized-steel cables with end connections made of cadmium-plated steel assemblies with brackets, swivel, and bolts designed for restraining cable service; and with an automatic-locking and clamping device or double-cable clips.

E. Hanger Rod Stiffener: Reinforcing steel angle clamped to hanger rod.

F. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install round and flat-oval ducts in maximum practical lengths.

D. Install ducts with fewest possible joints.

E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

H. Install ducts with a clearance of 1 inch (25 mm), plus allowance for insulation thickness.

I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches (38 mm).

K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Division 23 Section "Air Duct Accessories" for fire and smoke dampers.

L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "Duct Cleanliness for New Construction Guidelines."

3.2 SEAM AND JOINT SEALING

A. Seal duct seams and joints for duct static-pressure and leakage classes specified in "Performance Requirements" Article, according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 1-2, "Standard Duct Sealing Requirements," unless otherwise indicated.
   1. Seal Class:
      a. Low Pressure Supply Ducts, up to 3 inch (750 Pa) Positive: Seal Class B
      b. Medium Pressure Supply Ducts Upstream of Air Terminal Units, Greater 3 inch (750 Pa) Positive: Seal Class A
      c. Low Pressure Supply Ducts Downstream of Air Terminal Units, up to 2 inch (500 Pa) Positive: Seal Class B
      d. Return Ducts, Negative 3 inch (750 Pa) or Less: Seal Class A
      e. Exhaust Ducts, Negative 3 inch (750 Pa) or Less: Seal Class B

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3.3 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
   1. Where practical, install concrete inserts before placing concrete.
   2. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches (100 mm) thick.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1 (Table 4-1M), "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches (610 mm) of each elbow and within 48 inches (1200 mm) of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet (5 m).

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.4 SEISMIC-RESTRAINT-DEVICE INSTALLATION

A. Install ducts with hangers and braces designed to support the duct and to restrain against seismic forces required by applicable building codes. Comply with SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems".
   1. Space lateral supports a maximum of 40 feet (12 m) o.c., and longitudinal supports a maximum of 80 feet (24 m) o.c.
   2. Brace a change of direction longer than 12 feet (3.7 m).

B. Select seismic-restraint devices with capacities adequate to carry present and future static and seismic loads.

C. Install cables so they do not bend across edges of adjacent equipment or building structure.

D. Install cable restraints on ducts that are suspended with vibration isolators.

E. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction.

F. Attachment to Structure: If specific attachment is not indicated, anchor bracing and restraints to structure, to flanges of beams, to upper truss chords of bar joists, or to concrete members.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

G. Drilling for and Setting Anchors:
   1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcement or embedded items during drilling. Notify the Architect if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
   2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
   3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
   4. Set anchors to manufacturer's recommended torque, using a torque wrench.
   5. Install zinc-coated steel anchors for interior applications and stainless-steel anchors for applications exposed to weather.

3.5 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Division 23 Section "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.6 PAINTING

A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Division 09 painting Sections.

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Leakage Tests:
   1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual."
   2. Test the following systems:
      a. Supply air.
      b. Make-up air.
   3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
   4. Test for leaks before insulation application.
   5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure. Give seven days' advance notice for testing.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

C. Duct System Cleanliness Tests:
   1. Visually inspect duct system to ensure that no visible contaminants are present.
   2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."
      a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.

D. Duct system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.8 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel except as follows:
   1. Acid-Resistant (Fume-Handling) Ducts:
      a. Type 316 stainless-steel sheet.
      b. Exposed to View: No. 3 finish.
      c. Concealed: No. 2D finish.
   2. Acid-Resistant (Fume-Handling) Ducts: PVC-coated, galvanized sheet steel with thicker coating on duct interior.
   3. Moist Environment Ducts: Aluminum.

B. Intermediate Reinforcement:
   1. Galvanized-Steel Ducts: Galvanized steel.
   2. Stainless-Steel Ducts: Galvanized steel.
   3. Aluminum Ducts: Aluminum or galvanized sheet steel coated with zinc chromate.

C. Elbow Configuration:
   1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Elbows."
      a. Velocity 1000 fpm (5 m/s) or Lower:
         1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
         2) Mitered Type RE 4 with turning vanes.
      b. Velocity 1000 to 1500 fpm (5 to 7.6 m/s):
         1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
         2) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."
      c. Velocity 1500 fpm (7.6 m/s) or Higher:
         1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
         2) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."
   2. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-3, "Round Duct Elbows."
      a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1) Velocity 1000 fpm (5 m/s) or Lower: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
2) Velocity 1000 to 1500 fpm (5 to 7.6 m/s): 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
3) Velocity 1500 fpm (7.6 m/s) or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.

b. Round Elbows, 12 Inches (305 mm) and Smaller in Diameter: Stamped or welded segmented.

c. Round Elbows, 14 Inches (356 mm) and Larger in Diameter: Welded segmented.

D. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-6, "Branch Connections."
   a. Rectangular Main to Rectangular Branch: 45-degree entry.
   b. Rectangular Main to Round Branch: Spin in.
2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees." Saddle taps are permitted in existing duct.
   a. Velocity 1000 fpm (5 m/s) or Lower: Conical tap.
   b. Velocity 1000 to 1500 fpm (5 to 7.6 m/s): Conical tap.
   c. Velocity 1500 fpm (7.6 m/s) or Higher: 45-degree lateral, or conical tap.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
1. Backdraft and pressure relief dampers.
2. Barometric relief dampers.
3. Manual volume dampers.
4. Control dampers.
5. Fire dampers.
6. Smoke dampers.
7. Combination fire and smoke dampers.
8. Corridor dampers.
9. Flange connectors.
10. Turning vanes.
11. Remote damper operators.
12. Duct-mounted access doors.
13. Flexible connectors.
14. Flexible ducts.
15. Duct accessory hardware.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.
1. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.
2. For all damper types, provide pressure drop graphs and data.
3. For control dampers, provide leakage rate data.
4. Wiring Diagrams: For power, signal, and control wiring.

B. Source quality-control reports.

C. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

B. Comply with AMCA 500-D testing for damper rating.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1.5 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
   1. Galvanized Coating Designation: G90 (Z275).
   2. Exposed-Surface Finish: Mill phosphatized.

C. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304, and having a No. 2 finish for concealed ducts and No. 3 finish for exposed ducts.

D. Aluminum Sheets: Comply with ASTM B 209 (ASTM B 209M), Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

E. Extruded Aluminum: Comply with ASTM B 221 (ASTM B 221M), Alloy 6063, Temper T6.

F. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

G. Tie Rods: Stainless steel, 1/4-inch (6-mm) minimum diameter for lengths 36 inches (900 mm) or less; 3/8-inch (10-mm) minimum diameter for lengths longer than 36 inches (900 mm).

2.2 BACKDRAFT DAMPERS

A. Manufacturers:
   1. Air Balance, Inc.
   2. Greenheck.
   3. Leader Industries.
   4. Ruskin Company.
   5. Vent Products Company, Inc.
   6. Or approved equal.

B. Description: Multiple-blade, parallel action gravity balanced, with blades of maximum 6-inch(150-mm) width, with sealed edges, assembled in rattle-free manner with 90-degree stop, steel ball bearings, and axles; adjustment device to permit setting for varying differential static pressure.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

C. Frame: 0.052-inch-(1.3-mm-) thick, galvanized sheet steel or 0.063-inch-(1.6-mm-) thick extruded aluminum, with welded corners and mounting flange.

D. Blades: 0.050-inch-(1.2-mm-) thick aluminum sheet.

E. Blade Seals: Neoprene.

F. Blade Axles: Aluminum.

G. Tie Bars and Brackets: Aluminum.

H. Return: Adjustable tension spring or counterbalanced.

I. For relief applications, provide counterbalanced.

2.3 VOLUME DAMPERS

A. Manufacturers:
1. Greenheck.
2. Leader Industries.
3. Ruskin Company.
4. Vent Products Company, Inc.
5. Air Balance, Inc.
6. Or approved equal.

B. General Description: Factory fabricated, with required hardware and accessories. Stiffen damper blades for stability. Include locking device to hold single-blade dampers in a fixed position without vibration. Close duct penetrations for damper components to seal duct consistent with pressure class.
1. Pressure Classes of 3-Inch wg(750 Pa) or Higher: End bearings or other seals for ducts with axles full length of damper blades and bearings at both ends of operating shaft.
2. Damper Limit (Height): 11 inch(275mm) for single-blade; greater than 11-inch shall be multiple blade.

C. Standard Volume Dampers: Single-blade or multiple opposed-blade design, standard leakage rating, suitable for horizontal or vertical applications. Material to match duct material; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
1. Steel Frames: Hat-shaped, galvanized or stainless sheet steel channels, minimum of 0.064 inch(1.62 mm) thick, with mitered and welded corners; frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts.
2. Roll-Formed Steel Blades: 0.064-inch-(1.62-mm-) thick, galvanized or stainless sheet steel.
3. Aluminum Frames: Hat-shaped, 0.10-inch-(2.5-mm-) thick, aluminum sheet channels; frames with flanges where indicated for attaching to walls; and flangeless frames where indicated for installing in ducts.
4. Roll-Formed Aluminum Blades: 0.10-inch-(2.5-mm-) thick aluminum sheet.
5. Extruded-Aluminum Blades: 0.010-inch-(2.5-mm-) thick extruded aluminum.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

6. Blade Axles: Galvanized steel, stainless steel, or nonferrous.
7. Bearings: Oil-impregnated bronze, molded synthetic, or stainless-steel sleeve.
8. Tie Bars and Brackets: Aluminum or galvanized steel.

D. Low-Leakage Volume Dampers: Multiple- or single-blade, parallel- or opposed-blade design as indicated, low-leakage rating, and suitable for horizontal or vertical applications. Material to match duct material.
1. Steel Frames: Galvanized or stainless sheet steel channels, minimum of 0.064 inch(1.62 mm) thick, with mitered and welded corners; frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts.
2. Roll-Formed Steel Blades: 0.064-inch-(1.62-mm-) thick, galvanized or stainless sheet steel.
3. Aluminum Frames: 0.10-inch-(2.5-mm-) thick, aluminum sheet channels; frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts.
4. Roll-Formed Aluminum Blades: 0.10-inch-(2.5-mm-) thick aluminum sheet.
5. Extruded-Aluminum Blades: 0.010-inch-(2.5-mm-) thick extruded aluminum.
6. Blade Axles: Stainless steel.
7. Bearings: Stainless-steel sleeve thrust or ball.
8. Blade Seals: Neoprene.
9. Jamb Seals: Cambered stainless steel.
10. Tie Bars and Brackets: Aluminum.

E. Jackshaft: 1-inch-(25-mm-) diameter, galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
1. Length and Number of Mountings: Appropriate to connect linkage of each damper in multiple-damper assembly.

F. Damper Hardware: Zinc-plated, die-cast core with dial and handle made of 3/32-inch-(2.4-mm-) thick zinc-plated steel, and a 3/4-inch(19-mm) hexagon locking nut. Include center hole to suit damper operating-rod size. Include elevated platform (stand-off bracket) for insulated duct mounting.

2.4 MOTORIZED CONTROL DAMPERS

A. Manufacturers:
1. Air Balance, Inc.
2. Greenheck.
3. Leader Industries.
4. Ruskin Company.
5. Vent Products Company, Inc.
6. Or approved equal.

B. Material to match duct material; use galvanized-steel accessories in galvanized-steel ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1. AMCA-rated, opposed-blade design; minimum of 0.1084-inch-(2.8-mm-) thick, galvanized-steel frames with holes for duct mounting; minimum of 0.0635-inch-(1.61-mm-) thick, galvanized-steel damper blades with maximum blade width of 8 inches(203 mm). Secure blades to 1/2-inch-(13-mm-) diameter, zinc-plated axles using zinc-plated hardware, with nylon blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.
2. Stainless Steel opposed blade design; minimum of 0.0635-inch- (1.6-mm-) thick, stainless steel frames; minimum of 0.0635-inch- (1.6-mm-) thick, stainless steel damper blades with maximum blade width of 6 inches (152 mm). Secure blades to 1/2-inch-(13-mm-) diameter, stainless steel axles using stainless steel hardware, with stainless bearings, all damper blade-linkage concealed in frame or exposed to airstream.
3. Operating Temperature Range: From minus 40 to plus 200 deg F(minus 40 to plus 93 deg C).
4. Provide opposed-blade design with seals rated for leakage at less than 10 cfm per sq. ft.(51 L/s per sq. m) of damper area, at differential pressure of 4-inch wg(995 Pa) when damper is being held by torque of 50 in. x lbf(5.6 N x m); when tested according to AMCA 500D.

2.5 FLANGE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Ductmate Industries, Inc.
2. Nexus PDQ; Division of Shilco Holdings Inc.
3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
4. Or approved equal.

B. Description: Roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.

C. Material: Galvanized or stainless steel.

D. Gage and Shape: Match connecting ductwork.

2.6 TURNING VANES

A. Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for vanes and vane runners. Vane runners shall automatically align vanes. Single thickness turning vanes may be used in ducts with velocities up to 1200 fpm.

B. Manufactured Turning Vanes: Fabricate 1-1/2-inch-(38-mm-) wide, single or double-vane, curved blades of galvanized sheet steel set 3/4 inch(19 mm) o.c.; support with bars perpendicular to blades set 2 inches(50 mm) o.c.; and set into vane runners suitable for duct mounting.
1. Manufacturers:
   a. Ductmate Industries, Inc.
   b. Duro Dyne Corp.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

c. METALAIRE, Inc.
d. Ward Industries, Inc.
e. Or approved equal.

2.7 REMOTE DAMPER OPERATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Pottorff; a division of PCI Industries, Inc.
2. Ventfabrics, Inc.
3. Young Regulator Company.
4. Or approved equal.

B. Description: Cable system designed for remote manual damper adjustment.

C. Tubing: Brass.

D. Cable: Stainless steel.

E. Wall-Box Mounting: Recessed, 3/4 inches (19 mm) deep.

F. Wall-Box Cover-Plate Material: Stainless steel.

2.8 DUCT-MOUNTED ACCESS DOORS

A. General Description: Fabricate doors airtight and suitable for duct pressure class.

B. Door: Double wall, duct mounted, rectangular; fabricated of galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class. Include vision panel where indicated. Include 1-by-1-inch(25-by-25-mm) butt or piano hinge and cam latches.
1. Manufacturers:
a. Air Balance, Inc.
b. Ductmate Industries, Inc.
c. Kees, Inc.
d. Leader Industries.
e. Or approved equal.
2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
3. Provide number of hinges and locks as follows:
a. Less Than 12 Inches(300 mm) Square: Secure with two sash locks.
b. Up to 18 Inches(450 mm) Square: Two hinges and two sash locks.
c. Up to 24 by 48 Inches(600 by 1200 mm): Three hinges and two compression latches with outside handles.
d. Sizes 24 by 48 Inches(600 by 1200 mm) and Larger: One additional hinge.
e. Hinges may be replaced with latches where clearance will not allow full range of access door opening.

C. Door: Double wall, duct mounted, round; fabricated of galvanized sheet metal with insulation fill and 1-inch(25-mm) thickness. Include cam latches.
1. Manufacturers:

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

a. Flexmaster U.S.A., Inc.
b. McGill Airflow Corporation.
c. Or approved equal.

2. Frame: Galvanized sheet steel, with spin-in notched frame.

D. Pressure Relief Access Door: Double wall and duct mounting; fabricated of galvanized or stainless sheet steel with insulation fill and thickness as indicated for duct pressure class. Include vision panel where indicated, latches, and retaining chain.

1. Manufacturers:
   a. Air Balance, Inc.
   b. Ductmate Industries, Inc.
   c. Greenheck.
   d. KEES, Inc.
   e. Or approved equal.
2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.

E. Seal around frame attachment to duct and door to frame with neoprene or foam rubber.

F. Insulation: 1-inch-(25-mm-) thick, fibrous-glass or polystyrene-foam board.

2.9 DUCT ACCESS PANEL ASSEMBLIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Ductmate Industries, Inc.
2. Flame Gard, Inc.
3. 3M.
4. Or approved equal.

B. Labeled according to UL 1978 by an NRTL.

C. Panel and Frame: Minimum thickness 0.0428-inch (1.1-mm) stainless steel.

D. Fasteners: Stainless steel. Panel fasteners shall not penetrate duct wall.

E. Gasket: Comply with NFPA 96; grease-tight, high-temperature ceramic fiber, rated for minimum 2000 deg F (1093 deg C).

F. Minimum Pressure Rating: 10-inch wg (2500 Pa), positive or negative.

2.10 FLEXIBLE CONNECTORS

A. Manufacturers:

1. Duro Dyne Corp.
2. Ventfabrics, Inc.
3. Ward Industries, Inc.
4. Or approved equal.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. General Description: Flame-retardant or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1.

C. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches(89 mm) wide attached to two strips of 2-3/4-inch-(70-mm-) wide, 0.028-inch-(0.7-mm-) thick, galvanized sheet steel or 0.032-inch-(0.8-mm-) thick aluminum sheets. Select metal compatible with ducts.

D. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
1. Minimum Weight: 26 oz./sq. yd.(880 g/sq. m).
2. Tensile Strength: 480 lbf/inch(84 N/mm) in the warp and 360 lbf/inch(63 N/mm) in the filling.
3. Service Temperature: Minus 40 to plus 200 deg F(Minus 40 to plus 93 deg C).

E. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
1. Minimum Weight: 24 oz./sq. yd.(810 g/sq. m).
2. Tensile Strength: 530 lbf/inch(93 N/mm) in the warp and 440 lbf/inch(77 N/mm) in the filling.
3. Service Temperature: Minus 50 to plus 250 deg F(Minus 45 to plus 121 deg C).

F. High-Corrosive-Environment System, Flexible Connectors: Glass fabric with chemical-resistant coating.
1. Minimum Weight: 14 oz./sq. yd.(474 g/sq. m).
2. Tensile Strength: 450 lbf/inch(79 N/mm) in the warp and 340 lbf/inch(60 N/mm) in the filling.
3. Service Temperature: Minus 67 to plus 500 deg F(Minus 55 to plus 260 deg C).

2.11 FLEXIBLE DUCTS

A. Manufacturers:
1. ATCO Rubber Products, Inc.
2. Clevatflex, Inc.
3. Flexmaster U.S.A., Inc.
4. Or approved equal.

B. Insulated-Duct Connectors: UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helically wound, spring-steel wire; 1-inch fibrous-glass insulation; aluminized vapor barrier film.
1. Pressure Rating: 10-inch wg(2500 Pa) positive and 1.0-inch wg(250 Pa) negative.
2. Maximum Air Velocity: 4000 fpm(20.3 m/s).
3. Temperature Range: Minus 20 to plus 210 deg F(Minus 28 to plus 99 deg C).

C. Flexible Duct Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action or nylon strap, in sizes 3 through 18 inches(75 to 450 mm) to suit duct size.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2.12 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

2.13 SPIN-IN FITTINGS

A. Conical spin-in with balance damper and without scoop. Balance damper must comply with requirements for volume dampers.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Install backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
   1. Coordinate subparagraphs below with Division 23 Section "Metal Ducts."Install steel volume dampers in steel ducts.
   2. Install aluminum volume dampers in aluminum ducts.

E. Set dampers to fully open position before testing, adjusting, and balancing.

F. Install test holes at fan inlets and outlets and elsewhere as indicated.

G. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
   1. On both sides of duct coils.
   2. Downstream from duct smoke detectors.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3. Adjacent to and close enough to fire, smoke, or combination fire/smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
4. At each change in direction and at maximum 50-foot (15-m) spacing.
5. Upstream of turning vanes.
6. Elsewhere as indicated.

H. Install access doors with swing against duct static pressure.

I. Access Door Sizes:
1. One-Hand or Inspection Access: 8 by 5 inches (200 by 125 mm).
2. Two-Hand Access: 12 by 6 inches (300 by 150 mm).
3. Head and Hand Access: 18 by 10 inches (460 by 250 mm).
4. Head and Shoulders Access: 21 by 14 inches (530 by 355 mm).
5. Body Access: 25 by 14 inches (635 by 355 mm).
6. Body plus Ladder Access: 25 by 17 inches (635 by 430 mm).

J. Label access doors according to Division 23 Section "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

K. Install flexible connectors to connect ducts to equipment.

L. For fans developing static pressures of 5-inch wg (1250 Pa) and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

M. Connect terminal units to supply ducts with maximum 12-inch (300-mm) lengths of flexible duct. Do not use flexible ducts to change directions.

N. Connect diffusers or light troffer boots to low-pressure ducts with maximum 60-inch (1500-mm) lengths of flexible duct clamped or strapped in place.

O. Connect flexible ducts to metal ducts with draw bands.

P. Install duct test holes where required for testing and balancing purposes.

Q. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch (6-mm) movement during start and stop of fans.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:
1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors and verify that purpose of access door can be performed.
3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

4. Inspect turning vanes for proper and secure installation.
5. Operate remote damper operators to verify full range of movement of operator and damper.

3.3 ADJUSTING

A. Adjust duct accessories for proper settings.

B. Adjust fire and smoke dampers for proper action.

C. Final positioning of manual-volume dampers is specified in Division 23 Section "Testing, Adjusting, and Balancing for HVAC".

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Propeller exhaust fans.
   2. Centrifugal wall ventilators.

1.3 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base fan-performance ratings on actual Project site elevations.

B. Operating Limits: Classify according to AMCA 99.

1.4 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:
   1. Certified fan performance curves with system operating conditions indicated.
   2. Certified fan sound-power ratings.
   3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
   4. Material thickness and finishes, including color charts.
   5. Dampers, including housings, linkages, and operators.
   6. Roof curbs.
   7. Fan speed controllers.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   1. Wiring Diagrams: Power, signal, and control wiring.
   2. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
   3. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.

C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

D. UL Standard: Power ventilators shall comply with UL 705.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver fans as factory-assembled unit, to the extent allowable by shipping limitations, with protective crating and covering.

B. Disassemble and reassemble units, as required for moving to final location, according to manufacturer's written instructions.

C. Lift and support units with manufacturer's designated lifting or supporting points.

1.7 COORDINATION

A. Coordinate size and location of structural-steel support members.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Belts: One set for each belt-driven unit.

PART 2 - PRODUCTS

2.1 CENTRIFUGAL WALL VENTILATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Greenheck Fan Company.
   2. Aerovent; a Twin City Fan Company.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3. Hartzell Fan, Inc.
4. Loren Cook Company.
5. Or approved equal.

B. Description: Direct- or belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, and accessories.

C. Housing: Heavy-gage, removable, spun-aluminum, dome top and outlet baffle; venturi inlet cone.

D. Fan Wheel: Aluminum hub and wheel with backward-inclined blades.

E. Belt-Driven Drive Assembly: Resiliently mounted to housing, with the following features:
1. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
2. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
3. Pulleys: Cast-iron, adjustable-pitch motor pulley.
4. Fan and motor isolated from exhaust airstream.

F. Accessories:
1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through internal aluminum conduit.
2. Bird Screens: Removable, 1/2-inch (13-mm) mesh, aluminum or brass wire.
3. Wall Grille: Ring type for flush mounting.
4. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in wall sleeve; factory set to close when fan stops.

2.2 PROPELLER FANS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Greenheck Fan Company.
2. Aerovent; a Twin City Fan Company.
3. Hartzell Fan, Inc.
4. Loren Cook Company.
5. Or approved equal.

B. Description: Direct- or belt-driven propeller fans consisting of fan blades, hub, housing, orifice ring, motor, drive assembly, and accessories.

C. Housing: Galvanized-steel sheet with flanged edges and integral orifice ring with baked-enamel finish coat applied after assembly.

D. Fan Wheel: Replaceable, cast- or stamped-aluminum blades fastened to cast-or stamped-aluminum hub; factory set pitch angle of blades.

E. Belt-Driven Drive Assembly: Resiliently mounted to housing, statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1. Service Factor Based on Fan Motor Size: 1.4.
2. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
3. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
   a. Ball-Bearing Rating Life: ABMA 9, L_{10} of 120,000 hours.
4. Pulleys: Cast iron with split, tapered bushing; dynamically balanced at factory.
5. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
6. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
7. Belt Guards: Fabricate of steel for motors mounted on outside of fan cabinet.

F. Accessories:
1. Gravity Shutters: Aluminum blades in aluminum frame; interlocked blades with nylon bearings.
2. Motor-Side Back Guard: Galvanized steel, complying with OSHA specifications, removable for maintenance.
3. Wall Sleeve: Galvanized steel to match fan and accessory size.
4. Weathershield Hood: Galvanized steel to match fan and accessory size.
5. Weathershield Front Guard: Galvanized steel with expanded metal screen.
6. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.

2.3 MOTORS

A. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

B. Enclosure Type: Totally enclosed, fan cooled. For use in hazardous areas.

2.4 SOURCE QUALITY CONTROL

A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install power ventilators level and plumb.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Support units using vibration- and seismic-control devices are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
   1. Secure vibration and seismic controls to concrete bases using anchor bolts cast in concrete base.

C. Support suspended units from structure using threaded steel rods and vibration-control devices are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

D. Install units with clearances for service and maintenance.

E. Label units according to requirements specified in Division 23 Section "Identification for HVAC Piping and Equipment."

3.2 CONNECTIONS

A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23 Section "Air Duct Accessories."

B. Install ducts adjacent to power ventilators to allow service and maintenance.

C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:
   1. Verify that shipping, blocking, and bracing are removed.
   2. Verify that unit is secure on mountings and supporting devices and connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
   3. Verify that cleaning and adjusting are complete.
   4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
   5. Adjust belt tension.
   6. Adjust damper linkages for proper damper operation.
   7. Verify lubrication for bearings and other moving parts.
   8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
   9. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
   10. Shut unit down and reconnect automatic temperature-control operators.
   11. Remove and replace malfunctioning units and retest as specified above.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.4 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Refer to Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.

D. Replace fan and motor pulleys as required to achieve design airflow.

E. Lubricate bearings.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Square louver face ceiling diffusers.
   2. Fixed face ceiling return/exhaust grilles.
   3. Linear slot diffusers.
   4. Sidewall supply grilles and registers.
   5. Side return/exhaust grilles and registers.

B. Related Sections:
   1. Division 23 Section "Air Duct Accessories" for volume-control dampers not integral to diffusers, registers, and grilles.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated, include the following:
   1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
   2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

B. Samples for Verification: For diffusers, registers, and grilles, in manufacturer's standard sizes to verify color selected.

C. Source quality-control reports.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Products: Subject to compliance with requirements, provide one of the products specified.
   2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 DIFFUSERS, REGISTERS, AND GRILLES

A. Square Louver Face Ceiling Diffuser (Type 1), based on Titus TDC:
   1. Manufacturers:

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

a. Anemostat; a Mestek Company.
b. Carnes.
c. METALAIRE, Inc.; Metal Industries Inc.
d. Price Industries.
e. Titus.
f. Or approved equal.

2. Material: Aluminum.
3. Finish: Baked enamel, white.
4. Face Size: 12 x 12 inches(300 by 300mm) or 24 x 24 inches(600 by 600mm). Refer to plans and schedules.
5. Mounting: Surface or lay-in to match ceiling type.
6. Pattern: Four-way core style, flush with ceiling, no dropped cones will be allowed.
7. Dampers: Butterfly.
8. Neck: 1 inch(25mm) high round flange. Refer to plans and schedules for sizes.

B. Fixed Face Ceiling Return/Exhaust Grille (Type 2), Based on Titus 50F:

1. Manufacturers:
   a. Anemostat; a Mestek Company.
   b. Carnes.
   c. Krueger.
   d. Price Industries.
   e. Titus.
   f. Or approved equal.
2. Material: Aluminum.
3. Finish: Baked enamel, white.
4. Face Arrangement: 1/2-by-1/2-by-1/2-inch(13-by-13-by-13-mm) grid core.
5. Frame: 1 inch(25 mm) wide.
6. Mounting: Surface mount or lay-in, based on ceiling.
7. Damper Type: Adjustable opposed-blade assembly.

C. Linear Slot Diffuser (Type 3), based on Titus ML:

1. Manufacturers:
   a. Anemostat; a Mestek Company.
   b. Carnes.
   c. Krueger.
   d. METALAIRE, Inc.; Metal Industries Inc.
   e. Price Industries.
   f. Titus.
   g. Or approved equal.
2. Material - Shell: Aluminum.
3. Material - Pattern Controller and Tees: Aluminum.
4. Finish - Face and Shell: Baked enamel, black.
5. Finish - Pattern Controller: Baked enamel, black.
6. Finish - Tees: Baked enamel, white.
7. Slot Width: 3/4 inch(19 mm) or 1 inch(25 mm). Refer to Schedules.
8. Number of Slots: As indicated on schedule.
9. Length: 48 inches(1200 mm).
10. Mounting: Surface or lay-in to match ceiling type.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

11. Accessories: Galvanized steel plenum with 1-inch(25 mm) thick foil faced external rigid insulation.

D. Adjustable Sidewall Supply Register (Type 4), based on Titus 300F:
1. Manufacturers:
   a. Anemostat; a Mestek Company.
   b. Carnes.
   c. Krueger.
   d. METALAIRE, Inc.; Metal Industries Inc.
   e. Price Industries.
   f. Titus.
   g. Or approved equal.
2. Material: Aluminum.
3. Finish: Baked enamel, white.
4. Face Blade Arrangement: Adjustable horizontal spaced 3/4-inch(19 mm) apart.
5. Frame: 1-1/4 inches(32 mm) wide.
6. Mounting: Countersunk screw.
7. Damper Type: Adjustable opposed-blade assembly.
8. Accessories: Front-blade gang operator.

E. Fixed Face Return/Exhaust Register (Type 5), based on Titus 33R:
1. Manufacturers:
   a. Anemostat; a Mestek Company.
   b. Carnes.
   c. Krueger.
   d. METALAIRE, Inc.; Metal Industries Inc.
   e. Price Industries.
   f. Titus.
   g. Or approved equal.
2. Material: Aluminum.
3. Finish: Baked enamel, white.
4. Face Blade Arrangement: Fixed horizontal spaced 1/2 inch(13 mm) apart.
5. Frame: 1-1/4 inches(32 mm) wide.
6. Mounting: Countersunk screw.
7. Damper Type: Adjustable opposed-blade assembly.

2.3 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install diffusers, registers, and grilles level and plumb.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Listed double-wall vents.

1.3 SUBMITTALS

A. Product Data: For the following:
   1. Special vents for use with Category III heating appliances.

B. Shop Drawings: For vents, breechings, chimneys, and stacks. Include plans, elevations, sections, details, and attachments to other work.
   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, methods of field assembly, components, hangers and seismic restraints, and location and size of each field connection.
   2. For installed products indicated to comply with design loads, include calculations required for selecting seismic restraints and structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

C. Welding certificates.

D. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain listed system components through one source from a single manufacturer.

B. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code--Steel," for hangers and supports and AWS D9.1/D9.1M, "Sheet Metal Welding Code," for shop and field welding of joints and seams in vents, breechings, and stacks.

C. Certified Sizing Calculations: Manufacturer shall certify venting system sizing calculations.

1.5 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of venting system that fail in materials or workmanship within specified warranty period. Failures include, but are not limited to, structural failures caused by expansion and contraction.
   1. Warranty Period: 10 years from date of Substantial Completion.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 2 - PRODUCTS

2.1 LISTED SPECIAL GAS VENTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Heat-Fab, Inc.
   2. Metal-Fab, Inc.
   3. Selkirk Inc.; Selkirk Metalbestos and Air Mate.
   4. Z-Flex; Flexmaster Canada Limited.
   5. Or approved equal.

B. Description: Double-wall metal vents tested according to UL 1738 and rated for 480 deg F (248 deg C) continuously, with positive or negative flue pressure complying with NFPA 211; must be for use with Category III heating appliances with separated combustion.

C. Construction: Inner shell and outer jacket separated by at least a 1/2-inch (13-mm) airspace.

D. Inner Shell: ASTM A 959, Type 29-4C stainless steel.

E. Outer Jacket: Stainless steel.

F. Accessories: Tees, elbows, increasers, draft-hood connectors, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly.
   1. Refer to the Drawings for routings and terminations.
   2. For round chimney top; must be designed to exclude minimum 98 percent of rainfall.

2.2 GUYING AND BRACING MATERIALS

A. Cable: Three galvanized, stranded wires of the following thickness:
   1. Minimum Size: 1/4 inch (6 mm) in diameter.
   2. For ID Sizes 4 to 15 Inches (100 to 381 mm): 5/16 inch (8 mm).

B. Pipe: Two galvanized steel, NPS 1-1/4 (DN 32).

C. Angle Iron: Two galvanized steel, 2 by 2 by 0.25 inch (50 by 50 by 6 mm).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of work.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3.2 APPLICATION

A. Listed Type B and BW Vents: Vents for certified gas appliances.

3.3 INSTALLATION OF LISTED VENTS AND CHIMNEYS

A. Locate to comply with minimum clearances from combustibles and minimum termi-nation heights according to product listing or NFPA 211, whichever is most stringent.

B. Support vents at intervals recommended by manufacturer to support weight of vents and all accessories, without exceeding appliance loading.

C. Lap joints in direction of flow.

3.4 CLEANING

A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes.

B. Clean breechings internally, during and after installation, to remove dust and debris. Clean external surfaces to remove welding slag and mill film. Grind welds smooth and apply touchup finish to match factory or shop finish.

C. Provide temporary closures at ends of breechings, chimneys, and stacks that are not completed or connected to equipment.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes gas-fired unit heaters.

1.3 SUBMITTALS

A. Product Data: For each type of fuel-fired unit heater indicated. Include rated capacities, operating characteristics, and accessories.
   1. Wiring Diagrams: Power, signal, and control wiring.

B. Manufacturer Seismic Qualification Certification: Submit certification that fuel-fired unit heaters, accessories, and components will withstand seismic forces defined in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment." Include the following:
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
      a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For fuel-fired unit heaters to include in emergency, operation, and maintenance manuals.

E. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.5 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace heat exchanger of fuel-fired unit heater that fails in materials or workmanship within specified warranty period.
   1. Warranty Period: 10 years from date of Substantial Completion.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 2 - PRODUCTS

2.1 GAS-FIRED UNIT HEATERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Lennox Industries, Inc.
   2. Modine Manufacturing Company.
   3. Reznor/Thomas & Betts Corporation.
   4. Sterling HVAC Products; Div. of Mestek Technology Inc.
   5. Trane Company.
   6. Or approved equal.

B. Description: Factory assembled, piped, and wired, and complying with ANSI Z83.8/ CSA 2.6.

C. Fuel Type: Design burner for natural gas having characteristics same as those of gas available at Project site.

D. Type of Venting: Separated combustion.

E. Housing: Steel, with integral draft hood and inserts for suspension mounting rods.
   1. External Casings and Cabinets: Baked enamel over corrosion-resistant-treated surface.
   2. Suspension Attachments: Reinforce suspension attachments at connection to fuel-fired unit heaters.
      a. Seismic Fabrication Requirements: Fabricate suspension attachments of fuel-fired unit heaters, accessories mountings, and components with reinforcement strong enough to withstand seismic forces defined in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" when fuel-fired unit heater is anchored to building structure.

F. Heat Exchanger: Stainless steel.

G. Burner Material: Stainless steel.

H. Unit Fan: Aluminum propeller blades riveted to heavy-gage steel spider bolted to cast-iron hub, dynamically balanced, and resiliently mounted.
   1. Fan-Blade Guard: Galvanized steel, complying with OSHA specifications, removable for maintenance.
   2. General requirements for motors are specified in Division 23.
      a. Motors: Totally enclosed with internal thermal-overload protection and complying with Division 23.
      b. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
      c. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 26 Sections.

I. Unit Fan with Corrosion-Protective Coating: Steel, centrifugal fan dynamically balanced and resiliently mounted.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1. Belt-Driven Drive Assembly: Resiliently mounted to housing, with the following features:
   a. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
   b. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
   c. Pulleys: Cast-iron, adjustable-pitch motor pulley.
2. General requirements for motors are specified in Division 23.
   a. Motors: Totally enclosed with internal thermal-overload protection and complying with Division 23.
   b. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
   c. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 26.

J. Controls: Regulated redundant gas valve containing pilot solenoid valve, electric gas valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff all in one body.
1. Gas Control Valve: Modulating.
2. Ignition: Electronically controlled electric spark with flame sensor.
3. Fan Thermal Switch: Operates fan on heat-exchanger temperature.
4. Vent Flow Verification: Flame rollout switch.
5. Control transformer.
6. High Limit: Thermal switch or fuse to stop burner.
7. Thermostat: Single-stage, wall-mounting type with 50 to 90 deg F (10 to 32 deg C) operating range and fan on switch.

K. Discharge Louvers: Independently adjustable horizontal blades.

L. Accessories:
1. Concentric, Terminal Vent Assembly: Combined combustion-air inlet and power-vent outlet with wall or roof caps. Include adapter assembly for connection to inlet and outlet pipes, and flashing for wall or roof penetration.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install and connect gas-fired unit heaters and associated fuel and vent features and systems according to NFPA 54, applicable local codes and regulations, and manufacturer's written installation instructions.

B. Suspended Units: Suspend from substrate using threaded rods, spring hangers, and building attachments. Secure rods to unit hanger attachments. Adjust hangers so unit is level and plumb.
1. Restrain the unit to resist code-required horizontal acceleration.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Install piping adjacent to fuel-fired unit heater to allow service and maintenance.

C. Gas Piping: Comply with Division 23. Connect gas piping to gas train inlet; provide union with enough clearance for burner removal and service.

D. Vent Connections: Comply with Division 23.

E. Electrical Connections: Comply with applicable requirements in Division 26 Sections.
   1. Install electrical devices furnished with heaters but not specified to be factory mounted.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

B. Tests and Inspections:
   1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
   2. Verify bearing lubrication.
   3. Verify proper motor rotation.
   4. Test Reports: Prepare a written report to record the following:
      a. Test procedures used.
      b. Test results that comply with requirements.
      c. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

C. Remove and replace malfunctioning units and retest as specified above.

3.4 ADJUSTING

A. Adjust initial temperature set points.

B. Adjust burner and other unit components for optimum heating performance and efficiency.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fuel-fired unit heaters. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes split-system air-conditioning and heat pump units consisting of separate evaporator-fan and compressor-condenser components. Units are designed for exposed or concealed mounting, and may be connected to ducts.

1.3 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Samples for Initial Selection: For units with factory-applied color finishes.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

F. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of split-system units and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Energy-Efficiency Ratio: Equal to or greater than prescribed by ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."

D. Coefficient of Performance: Equal to or greater than prescribed by ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."

E. Units shall be designed to operate with HCFC-free refrigerants.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1.5 COORDINATION

A. Coordinate size and location of concrete bases for units. Cast anchor-bolt inserts into bases.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Five years from date of Substantial Completion.

1.7 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Filters: Two sets of filters for each unit.
   2. Fan Belts: One set of belts for each unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Carrier Air Conditioning; Div. of Carrier Corporation.
   2. Mitsubishi Electric.
   3. Trane Company (The); Unitary Products Group.
   4. York International Corp.
   5. Or approved equal.

2.2 FLOOR-MOUNTING, EVAPORATOR-FAN COMPONENTS

A. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect.
   1. Insulation: Faced, glass-fiber, duct liner.
   2. Drain Pans: Galvanized steel, with connection for drain; insulated.

B. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with thermal-expansion valve.

C. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements with refractory ceramic support bushings; automatic-reset thermal cutout; built-in magnetic contactors; manual-reset thermal cutout; airflow proving device; and one-time fuses in terminal box for overcurrent protection.

D. Fan: Direct drive, centrifugal.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

E. Fan Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
   1. Special Motor Features: Multitapped, multispeed with internal thermal protection and permanent lubrication.

F. Filters: Permanent, cleanable.

2.3 WALL-MOUNTING, EVAPORATOR-FAN COMPONENTS

A. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect, and discharge drain pans with drain connection.

B. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with thermal-expansion valve.

C. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements with refractory ceramic support bushings; automatic-reset thermal cutout; built-in magnetic contactors; manual-reset thermal cutout; airflow proving device; and one-time fuses in terminal box for overcurrent protection.

D. Fan: Direct drive, centrifugal fan.

E. Fan Motors: Comply with requirements in Division 23.
   1. Special Motor Features: Multitapped, multispeed with internal thermal protection and permanent lubrication.

F. Filters: Permanent, cleanable.

2.4 AIR-COOLED, COMPRESSOR-CONDENSER COMPONENTS

A. Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.

B. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
   1. Compressor Type: Reciprocating or scroll.
   2. Refrigerant Charge: R-407C or R-410A.

C. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with liquid subcooler; phenolic or equal coating for use in corrosive environments.

D. Heat Pump Components: Reversing valve and low-temperature air cut-off thermostat.

E. Fan: Aluminum-propeller type, directly connected to motor.

F. Motor: Permanently lubricated, with integral thermal-overload protection.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

G. Low Ambient Kit: Permits operation down to 45 deg F (7 deg C).

H. Mounting Base: Polyethylene.

2.5 ACCESSORIES

A. Thermostat: Low voltage with subbase to control compressor and evaporator fan.

B. Thermostat for Ductless Systems: Wireless infrared functioning to remotely control compressor and evaporator fan, with the following features:
1. Compressor time delay.
2. 24-hour time control of system stop and start.
3. Liquid-crystal display indicating temperature, set-point temperature, time setting, operating mode, and fan speed.
4. Fan-speed selection, including auto setting.

C. Automatic-reset timer to prevent rapid cycling of compressor.

D. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units level and plumb.

B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure. Refer to Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" for additional requirements.

C. Install ground-mounting, compressor-condenser components on 4-inch- (100-mm-) thick, reinforced concrete base; 4 inches (100 mm) larger on each side than unit. Coordinate anchor installation with concrete base.

D. Install roof-mounting compressor-condenser components on equipment supports. Anchor units to supports with removable, cadmium-plated fasteners.

E. Install seismic restraints as required by local codes.

F. Install compressor-condenser components on vibration isolators. Refer to Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

G. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to unit to allow service and maintenance.

C. Duct Connections: Duct installation requirements are specified in Division 23 Section "Metal Ducts." Drawings indicate the general arrangement of ducts. Connect supply and return ducts to split-system air-conditioning units with flexible duct connectors. Flexible duct connectors are specified in Division 23 Section "Air Duct Accessories."

D. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

E. Electrical Connections: Comply with requirements in Division 26 Sections for power wiring, switches, and motor controls.

3.3 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:
   1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Remove and replace malfunctioning units and retest as specified above.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes general requirements for electrical field testing and inspecting. Detailed requirements are specified in each Section containing components that require testing. General requirements include the following:
   1. Qualifications of testing agencies and their personnel.
   2. Suitability of test equipment.
   3. Calibration of test instruments.
   4. Coordination requirements for testing and inspecting.
   5. Reporting requirements for testing and inspecting.
   6. Power distribution inspecting requirements.

1.3 QUALITY ASSURANCE

A. Test Equipment Suitability: Comply with NETA ATS, Section 5.2.

B. Test Equipment Calibration: Comply with NETA ATS, Section 5.3.

PART 2 - NOT USED

PART 3 - EXECUTION

3.1 GENERAL TESTS AND INSPECTIONS

A. Test and Inspection Reports: In addition to requirements specified elsewhere, report the following:
   1. Manufacturer's written testing and inspecting instructions.
   2. Calibration and adjustment settings of adjustable and interchangeable devices involved in tests.
   3. Tabulation of expected measurement results made before measurements.
   4. Tabulation of "as-found" and "as-left" measurement and observation results.

B. Power Distribution System: To facilitate Engineer’s electrical observation of the power distribution system, schedule a time during which all new power distribution equipment is de-energized, and all panelboard, switchboard, switchgear, disconnects, and transfer switches covers removed. This shall occur after all feeder and branch conductors have been installed and terminated. Provide a letter confirming the power distribution equipment installation is ready for this observation at least two weeks prior to the scheduled observation. This observation will be scheduled during regular business hours. Provide temporary generators and lighting required to illuminate each electrical room to allow safe observation of this equipment during the time building power is removed.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. General Requirements specifically applicable to Division 26, in addition to Division 01 provisions.

1.3 COORDINATION

A. Coordinate the Work specified in this Division under provisions of applicable Sections of Division 01.

B. Prepare drawings showing proposed rearrangement of Work to meet job conditions, including changes to Work specified under other Sections. Obtain written permission from the Engineer before proceeding.

C. Electrical drawings are diagrammatic and shall not be scaled for exact locations. If requested, any outlet or device shall be relocated up to six feet in any direction prior to rough in with no change in price.

D. Coordinate the installation of electrical items including, but not limited to, conduits, outlet boxes, and fixture mounting studs in precast concrete structural elements. All such electrical items shall be installed in precast forms before concrete is poured. Surface mounting of such electrical boxes, devices, or conduit shall not be permitted unless specifically noted on the Drawings.

E. The Contractor shall include all Bowling Green Municipal Utilities fees and charges associated with providing both temporary and permanent electrical service.

1.4 REFERENCES

A. IECC 2006.

B. NFPA-30 2008 - Flammable and Combustible Liquids Code

C. NFPA-37 2006 - Stationary Combustion Engines and Gas Turbines

D. NFPA-70 2005 - National Electrical Code

E. NFPA-90A 2002 - Installation of Air Conditioning and Ventilation Systems

F. NFPA-101 2006 - Life Safety Code

G. NFPA-110 2005 - Emergency and Standby Power Systems

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

H. Kentucky Building Code 2007

I. ADA - Americans with Disabilities Act (1992)

1.5 REGULATORY REQUIREMENTS

A. Conform to ANSI/NFPA 70 and all other applicable NFPA codes.

B. Conform to all applicable Building Codes.

C. Obtain all required electrical permits and inspections from Authority Having Jurisdiction. Pay all associated fees.

D. Completed electrical work shall meet requirements of the Occupational Safety and Health Act of 2006, its subsequent amendments, and interpretations of the Act promulgated by Occupational Safety and Health Administration of the Department of Labor.

1.6 GENERAL SCOPE OF ELECTRICAL WORK

A. The scope of electrical work is defined by these Specifications and Drawings. If the Specifications and/or the Drawings are in conflict, the Contractor shall notify the Engineer, before proceeding with that portion of the work, for an interpretation of precedence. The Contractor pricing shall reflect the more expensive option when a conflict cannot be resolved prior to bidding.

B. Provide all electrical systems in complete working order.

C. Provide concrete foundations, curbs, housekeeping pads, lighting pole bases, duct banks, etc., required for the installation of electrical equipment as specified under other Sections. Provide 4-inch housekeeping curbs under the footprint of all floor-mounted switchboards, panelboards, motor control centers, transformers, and any other item indicated on the drawings. Curb to extend 2-inches beyond equipment footprint on all sides. Provide1/2- inch chamfer.

D. Provide cutting and patching required for electrical installation as specified under other Sections. All patching shall maintain rating of the wall or floor where it occurs.

E. The Contractor shall arrange for temporary electrical service required for the entire project during construction. Provide a minimum of one 100-watt lamp and one duplex receptacle in each 250 square feet of floor area, and as many 208 and 480-volt outlets and services as required. The Contractor shall arrange for orderly transfer between temporary and permanent electrical services. All temporary wiring shall be installed in a neat and workmanlike manner. Comply with NEC for all temporary wiring. Remove all temporary wiring after permanent installation is complete and operational.

F. All equipment shall be installed in accordance with manufacturer's recommendations. Where conflicts occur between Contract Documents and these recommendations, a ruling shall be requested of the Engineer.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

G. Protect work and materials from damage by weather, entrance of water and dirt. Cap conduit during installation in an approved manner. Taping shall be unacceptable. Avoid damage to materials and equipment in place. Satisfactorily repair or remove and replace damaged work with new materials. Deliver equipment and materials to job site in original, unopened, labeled containers. Store ferrous materials to prevent rusting. Store materials and equipment to prevent staining and discoloring. All material shall be stored in or under a permanent structure.

H. Provide equipment and/or wiring normally furnished or required for complete electrical systems but not specifically specified on the drawings or in specifications, as though specified by both.

I. Execution of contract is evidence that Contractor has examined all drawings and specifications related to Work, has visited the site, inspected areas to be renovated, and is informed to extent and character of Work.

J. In event that project is occupied or systems placed in operation in several phases at Owner's request, guarantee and warranty will begin on date each system or item of equipment is accepted by Owner.

K. All starters not furnished as an integral part of mechanical and plumbing equipment shall be provided as specified under Division 26. Starters which are an integral part of a control panel provided with the mechanical and plumbing equipment (compressors, vacuum pumps, etc.) or starters which are furnished as a standard for the equipment (i.e., chillers, compressors, vacuum pumps, etc.) shall be by Division 23.

1.7 QUALITY ASSURANCE

A. The Contractor shall employ personnel that have been regularly engaged in electrical installation work of similar size projects. The Contractor must be able to demonstrate experience with design and installation of electrical equipment by similar size projects at the request of the Engineer.

B. Provide and/or be an active party to a meaningful Quality Assurance program. To assist the Contractor in this program, the specifications contained herein are set forth as the minimum acceptable Quality Assurance requirements. This does not relieve the Contractor from executing other Quality Assurance measures to obtain a complete operating facility within the scope of this project.

C. The Contractor shall insure that all workmanship, all materials employed, all required equipment and the manner and method of installation conform to accepted construction and engineering practices, and that each piece of equipment is in satisfactory working condition to satisfactorily perform its functional operation.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1.8 WARRANTY

A. The entire electrical system, including all material, components and equipment furnished under this Division, and all installation furnished under this Division shall be fully warranted for one year minimum under applicable provisions of Division 01. Provide longer warranty period where specified for items where required by other sections of this specification.

1.9 SUBMITTALS

A. Submit inspection and permit certificates under provisions of applicable Sections of Division 01.

B. Include certificate of final inspection and acceptance from all authorities having jurisdiction.

C. Electrical power distribution studies are required to be submitted along with power distribution system equipment submittals. Refer to Division 26 Section "Power Distribution Equipment Studies".

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Materials and Equipment: Acceptable to the authorities having jurisdiction as suitable for the use intended.

B. All material shall be UL listed where such labels are available. Provide additional listings for items where required in the specifications.

C. All material shall be new, unless specifically indicated on the drawings as existing to be reused.

PART 3 - EXECUTION

3.1 WORKMANSHIP

A. Install work in a workmanlike manner using procedures defined in NECA Standard of Installation.

B. Provide flashing and/or pitch pockets at all conduit penetrations of the roof.

C. Arrange for chases, slots or openings in other building components during progress of construction, to allow for electrical installation.

D. Install access panel or doors where items are concealed behind inaccessible finished surfaces.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Building wires and cables rated 600 V and less.
   2. Connectors, splices, and terminations rated 600 V and less.
   3. Sleeves and sleeve seals for cables.

1.3 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

B. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Qualification Data: For testing agency.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

1.6 COORDINATION

A. Set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. American Insulated Wire Corp.; a Leviton Company.
   2. General Cable Corporation.
   3. Senator Wire & Cable Company.
   4. Southwire Company.
   5. Or approved equal.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Copper Conductors: Comply with NEMA WC 70.

C. Conductor Insulation: Comply with NEMA WC 70 for Types THHN-THWN and XHHW.

D. Multiconductor Cable: Comply with NEMA WC 70 for tray table, Type TC, with ground wire.

2.2 CONNECTORS AND SPLICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. AFC Cable Systems, Inc.
2. Hubbell Power Systems, Inc.
3. O-Z/Gedney; EGS Electrical Group LLC.
4. 3M; Electrical Products Division.
5. AMP, Inc.
6. Or approved equal.

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

2.3 SLEEVES FOR CABLES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

C. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.138-inch (3.5-mm) thickness as indicated and of length to suit application.

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper, unless otherwise noted on drawings. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type THHN-THWN, single conductors in raceway.

B. Exposed Feeders: Type THHN-THWN, single conductors in raceway.

C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN-THWN, single conductors in raceway.

D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.

E. Exposed Branch Circuits, Including in Crawlspaces: Type THHN-THWN, single conductors in raceway.

F. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.

G. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.

H. Cord Drops and Portable Appliance Connections: Type SO, hard service cord.

I. Class 1 Control Circuits: Type THHN-THWN, in raceway.

J. Class 2 Control Circuits: Type THHN-THWN, in raceway.

K. Light fixture wiring shall be suitable for the environmental conditions and temperatures to which the conductors will be subjected.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors in dry, finished locations, unless otherwise indicated.

B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

E. Support cables according to Division 26 Section "Hangers and Supports for Electrical Systems."

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

F. Identify and color-code conductors and cables according to Division 26 Section "Identification for Electrical Systems."

G. Use no wire smaller than #12 AWG for power and lighting circuits except for tap conductors between light fixture terminal connections and its outlet box (fixture tails) in accordance with NEC Article 410 which may be #14 AWG. Use no wire smaller than #14 AWG for control wiring. Refer to drawings for additional sizing information.

H. Use #10 AWG conductor for 20 ampere, 120 volt branch circuit with total circuit length longer than 75 feet and for 20 ampere, 277 volt branch circuit with total circuit length longer than 175 feet. Refer to Drawings for longer circuits such as site lighting for wire sizes. Provide #12 AWG tap at fixtures where circuit wire exceeds #8 AWG.

I. Neatly train and lace wiring inside boxes, equipment and panelboards.

J. Make conductor lengths for parallel circuits equal.

K. Branch circuit homeruns to panelboards may be grouped into four wire branch circuits, with three phase conductors, and a common neutral provided that each of the three phase conductors originate from different phases in the same panelboard. No more than three circuits with shared neutral shall be installed in a single homrun conduit without permission of the Design Professional of Record. Grouping of conductors with non-linear loads may require oversizing the neutral. All proposed grouping shall be submitted to the Architect for approval prior to installation. The Contractor shall increase the neutral size if directed by the Design Professional of Record.

L. Do not install more than one feeder circuit in a conduit.

M. Do not exceed the maximum bending radius recommended by the manufacturer of the conductor.

3.4 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches (150 mm) of slack.

D. For solid copper wire #10 AWG and smaller, use insulated spring wire connectors.

E. For stranded conductors #10 AWG and smaller use insulated pressure connectors.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

F. Use compression connectors equal to 3M Scotchlok 10,000 Series for splices and taps 8 AWG and larger. Tape uninsulated conductors and connectors with electrical tape to 150 percent of the insulation value of conductor. Tape shall be equal to 3M Super 33+.

G. For terminations #8 AWG and larger, other than lugs supplied with equipment, use copper compression lugs equal to 3M Scotchlok 30,000 Series. Use one hole lugs for conductors up to #1/0 AWG. Use two hole lugs for conductors #1/0 AWG and larger.

H. Thoroughly clean wires before installing lugs and connectors.

I. Splice branch circuits only in junction boxes or outlet boxes. Splices in panelboards shall not be permitted. Feeder conductors shall be continuous from origin to termination. Splices in feeders shall not be permitted unless written approval by the Architect is obtained.

J. Terminate spare conductors with insulated spring wire connector and secured with electrical tape.

K. Double lugging of any phase wire, neutral or ground wire in a panelboard or switchboard shall not be allowed.

L. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches(150 mm) of slack.

3.5 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07.

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Rectangular Sleeve Minimum Metal Thickness:
1. For sleeve rectangle perimeter less than 50 inches (1270 mm) and no side greater than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
2. For sleeve rectangle perimeter equal to, or greater than, 50 inches (1270 mm) and 1 or more sides equal to, or greater than, 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

E. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

F. Cut sleeves to length for mounting flush with both wall surfaces.

G. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level.

H. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and cable unless sleeve seal is to be installed.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

I. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.

J. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and cable, using joint sealant appropriate for size, depth, and location of joint according to Division 07 Section "Joint Sealants."

K. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at cable penetrations. Install sleeves and seal with firestop materials according to Division 07 Section "Penetration Firestopping."

L. Roof-Penetration Sleeves: Seal penetration of individual cables with flexible boot-type flashing units applied in coordination with roofing work.

M. Aboveground Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Size sleeves to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

N. Underground Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between cable and sleeve for installing mechanical sleeve seals.

3.6 SLEEVE-SEAL INSTALLATION

A. Install to seal underground exterior-wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for cable material and size. Position cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.7 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Division 07.

3.8 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:
1. After installing conductors and cables and before electrical circuitry has been energized, test feeder conductors and conductors feeding the following critical equipment and services for compliance with requirements.

C. Testing: Perform the following field quality-control testing:
1. Torque test conductor connections and terminations to manufacturer's recommended values using a calibrated torque wrench.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2. Perform continuity test at all power and equipment branch circuit conductors. Verify proper phasing connections.
3. Perform an insulation resistance test using a 100 volt "Meggar" on each conductor in all feeder circuits. Test shall be conducted from conductor to ground with the other conductors in that circuit grounded. Voltage shall be applied until Meggar reading is constant, three minutes minimum. Minimum acceptable resistance shall be 50 megaohms, corrected to 60 degrees F for new conductors.
4. Perform insulation resistance tests on all branch circuit conductors that have apparent physical insulation damage and any other branch circuit conductors when requested by Architect. Tests shall be as specified for feeder conductors.
5. Test for compliance with requirements after installing conductors and cables and before electrical circuitry has been energized.
6. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.3.1. Certify compliance with test parameters.
7. Replace all failing conductors and retest for compliance with all requirements above.
8. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

D. Test Reports: Prepare a written report to record the following:
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

E. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.3 SUMMARY

A. This Section includes methods and materials for grounding systems and equipment, plus the following special applications:
   1. Common ground bonding with lightning protection system.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features specified in Part 3 "Field Quality Control" Article, including the following:
   1. Test wells.
   2. Ground rods.
   3. Ground rings.

C. Qualification Data: For testing agency and testing agency's field supervisor.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For grounding to include the following in emergency, operation, and maintenance manuals:
   1. Instructions for periodic testing and inspection of grounding features at test wells based on NFPA 70B.
      a. Tests shall be conducted to determine if ground resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if they do not.
      b. Include recommended testing intervals.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
   1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association to supervise on-site testing specified in Part 3.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:
1. Stranded Conductors: ASTM B 8.
2. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
3. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
4. Tinned Bonding Jumper: Tinned-copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

C. Grounding Bus: Rectangular bars of annealed copper, 1/4 by 2 inches (6 by 50 mm) in cross section, unless otherwise indicated; with insulators.

2.2 CONNECTORS

A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.
1. Pipe Connectors: Clamp type, sized for pipe.

C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.3 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad, steel; 3/4 inch by10 feet (19 mm by 3 m) in diameter.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger, unless otherwise indicated.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Underground Grounding Conductors: Install bare copper conductor, No. 4/0 AWG minimum.
   1. Bury at least 36 inches (900 mm) below grade.

C. Conductor Terminations and Connections:
   1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
   2. Underground Connections: Welded connectors, except at test wells and as otherwise indicated.
   3. Connections to Ground Rods at Test Wells: Bolted connectors.
   4. Connections to Structural Steel: Welded connectors.

3.2 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

A. Comply with IEEE C2 grounding requirements.

3.3 EQUIPMENT GROUNDING

A. Comply with NFPA 70, Article 250, for types, minimum sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.

B. Install equipment grounding conductors in all feeders and branch circuits. Provide a grounding conductor in all switch legs. Provide a grounding conductor in all control wiring circuits 120 volts and above. Refer to panelboard schedules and one line diagram for grounding conductor size other than #12 AWG. The minimum size grounding conductor shall be #12 AWG. Terminate each end on a grounding, lug, bus or bushing as appropriate.

C. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

D. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

E. Signal and Communication Equipment: For telephone, alarm, voice and data, and other communication equipment, provide No. 6 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
   1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-2-by-12-inch (6-by-50-by-300-mm) grounding bus.

F. Metal Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

G. Grounding conductors shall not be double lugged in panelboard ground bars.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

H. Provide bonding bushings on all feeder conduit terminations in all panelboards, switchboards, and motor control centers. Terminate grounding conductor to panelboard ground bar. Provide a jumper of equal size between the ground bar and the bonding bushing. Size grounding jumper per "Grounding Electrode Conductor for Alternating Current Systems" of NFPA 70.

I. Provide green tape on all grounding conductors larger than #10 AWG.

J. Metallic Sleeves: Where sleeving is required to be metallic, bond both ends of sleeve as required by NEC Article 250.

3.4 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Ground Rods: Drive rods until tops are 2 inches (50 mm) below finished floor or final grade, unless otherwise indicated.
   1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.
   2. For grounding electrode system, install at least three rods spaced at least 10 feet from each other and located at least the same distance from other grounding electrodes, and connect to service grounding electrode conductor.

C. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.
   1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
   2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.
   3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.

D. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.

E. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet (18 m) apart.

F. Ground Ring: Install grounding conductor systems as indicated on the Drawings.
   1. Install copper conductor not less than No. 4/0 AWG for ground ring and for taps to building steel.
   2. Bury ground ring not less than 36 inches (900 mm) from building foundation, and not less than 30 inches (750mm) deep.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3.5 CONNECTIONS

A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
   1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
   2. Make connections with clean, bare metal at points of contact.
   3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
   4. Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.
   5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

B. Exothermic-Welded Connections: Comply with manufacturer's written instructions. Welds that are puffed up or show convex surfaces indicating improper cleaning are not acceptable. Thoroughly sand and clean all piping and conductors prior to applying a thermal weld.

C. Equipment Grounding Conductor Terminations: For #8 AWG and larger, use pressure-type grounding lugs. #10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.

D. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.

E. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.6 FIELD QUALITY CONTROL

A. Testing: Perform the following tests and inspections and prepare test reports:
   1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
   2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells. Make tests at ground rods before any conductors are connected.
      a. Measure ground resistance not less than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
      b. Perform tests by fall-of-potential method according to IEEE 81.
   3. Prepare dimensioned drawings locating each test well, ground rod and ground rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Report measured ground resistances that exceed the following values:
   1. Power and Lighting Equipment or System with Capacity 1000 kVA: 5 ohms.
   2. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
   3. Power Distribution Units or Panelboards Serving Electronic Equipment: 1 ohm(s).

C. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Engineer promptly and include recommendations to reduce ground resistance.

D. Submit photographs of all underground connections prior to covering connection.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Hangers and supports for electrical equipment systems.
   2. Construction requirements for concrete bases.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. IMC: Intermediate metal conduit.

C. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.5 SUBMITTALS

A. Product Data: For the following:
   1. Steel slotted support systems.
   2. Nonmetallic slotted support systems.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
   1. Trapeze hangers. Include Product Data for components.
   2. Steel slotted channel systems. Include Product Data for components.
   3. Nonmetallic slotted channel systems. Include Product Data for components.
   4. Equipment supports.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

C. Welding certificates.

1.6 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Comply with NFPA 70.

1.7 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Allied Tube & Conduit.
      b. Cooper B-Line, Inc.; a division of Cooper Industries.
      c. ERICO International Corporation.
      d. GS Metals Corp.
      e. Thomas & Betts Corporation.
      f. Unistrut; Tyco International, Ltd.
      g. Wesanco, Inc.
   3. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
   4. Corrosive Locations: Stainless steel.
   5. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
   6. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
   7. Channel Dimensions: Selected for applicable load criteria.

B. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with 9/16-inch- (14-mm-) diameter holes at a maximum of 8 inches (200 mm) o.c., in at least 1 surface.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Allied Tube & Conduit.
      b. Cooper B-Line, Inc.; a division of Cooper Industries.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

c. Fabco Plastics Wholesale Limited.
d. Seasafe, Inc.

2. Fittings and Accessories: Products of channel and angle manufacturer and designed for use with those items.
3. Fitting and Accessory Materials: Same as channels and angles, except metal items may be stainless steel.
4. Rated Strength: Selected to suit applicable load criteria.

C. Raceway and Cable Supports: As described in NECA 1 and NECA 101 and as required by applicable NEC Article for type of raceway used.

D. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

E. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

F. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1) Hilti Inc.
2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
3) MKT Fastening, LLC.
4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
2. Mechanical-Expansion Anchors: Insert-wedge-type, stainless steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1) Cooper B-Line, Inc.; a division of Cooper Industries.
2) Empire Tool and Manufacturing Co., Inc.
3) Hilti Inc.
4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
5) MKT Fastening, LLC.
3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
6. Toggle Bolts: All-steel springhead type.
7. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
   1. Secure raceways and cables to these supports with two-bolt conduit clamps.

D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch (38-mm) and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
   1. To Wood: Fasten with lag screws or through bolts.
   2. To New Concrete: Bolt to concrete inserts.
   3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
   4. To Existing Concrete: Expansion anchor fasteners.
   5. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
   6. To Light Steel: Sheet metal screws.
   7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

A. Construct concrete bases of dimensions indicated but not less than 4 inches (100 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use 3500-psi (20.7-MPa), 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 Section "Cast-in-Place Concrete."

C. Anchor equipment to concrete base.
   1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   2. Install anchor bolts to elevations required for proper attachment to supported equipment.
   3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3.5 PAINTING

A. Touchup: Comply with requirements in Division 09 Section "Protective Coatings" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 WORK INCLUDED

A. Hinged cover enclosures. This specification is for miscellaneous cabinets and enclosures, but does not include cabinets or enclosures which are part of a manufactured system such as intercom, etc.

B. Cabinets.

C. Terminal blocks and accessories.

1.3 REFERENCES

A. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

B. ANSI/NEMA ICS 1 - Industrial Control and Systems.

C. ANSI/NEMA ICS 4 - Terminal Blocks for Industrial Control Equipment and Systems.

D. ANSI/NEMA ICS 6 - Enclosures for Industrial Control Equipment and Systems.

1.4 SUBMITTALS

A. Submit product data under provisions of applicable Sections of Division 1.

B. Shop Drawings for Equipment Panels: Include wiring schematic diagram, wiring diagram, outline drawing and construction diagram as described in ANSI/NEMA ICS 1.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Cooper Crouse-Hinds, Div. of Cooper Industries, Inc.
2. EGS/Appleton Electric.
3. Erickson Electrical Equipment Company.
4. Hoffman.
5. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
6. O-Z/Gedney; a unit of General Signal.
7. RACO; a Hubbell Company.
8. Robroy Industries, Inc.; Enclosure Division.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

9. Scott Fetzer Co.; Adalet Division.
10. Spring City Electrical Manufacturing Company.
11. Thomas & Betts Corporation.
12. Walker Systems, Inc.; Wiremold Company.
13. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.
14. Or approved equal.

2.2 HINGED COVER ENCLOSURES

A. Construction: NEMA 250.
   1. Indoor Dry, Clean Finished Locations: NEMA 250, Type 1.
   2. Outdoor Locations: NEMA 250, Type 4X.
   3. Other Wet or Damp Indoor Locations: NEMA 250, Type 4X.
   4. Hazardous Areas Indicated on the Drawings: NEMA 250, Type 7.

B. Finish: Manufacturer's standard enamel finish.

C. Covers: Continuous hinge, held closed by flush latch operable by key. Two keys shall be provided with each cover.

D. Panel for Mounting Terminal Blocks or Electrical Components: 14 gage steel, white enamel finish.

2.3 CABINETS

A. Cabinet Boxes: Galvanized steel with removable endwalls, 30 inches wide, 30 inches high, and 12 inches deep. Provide 3/4 inch thick plywood backboard, grade C-D minimum, painted matte white, for mounting terminal blocks.

B. Cabinet Fronts: Steel, flush or surface type as indicated on Drawings with concealed trim clamps, concealed hinge and flush lock; finish in gray baked enamel.

2.4 TERMINAL BLOCKS AND ACCESSORIES

A. Terminal Blocks: ANSI/NEMA ICS 4; UL listed.

B. Power Terminals: Unit construction type, closed-back type, with tubular pressure screw connectors, rated 600 volts.

C. Signal and Control Terminals: Modular construction type, channel mounted; tubular pressure screw connectors, rated 300 volts.

2.5 FABRICATION

A. Shop-assemble enclosures and cabinets housing terminal blocks or electrical components in accordance with ANSI/NEMA ICS 6.

B. Provide knockouts on enclosures.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

C. Provide fabricated metal protective pocket attached to the inside front cover with schematic diagram, connection diagram, and layout drawing of control wiring and components within enclosure.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install cabinets and enclosures plumb; anchor securely to wall and structural supports at each corner, minimum. Refer to the drawings for specific mounting heights and labeling.

B. Provide fabricated metal accessory feet for free-standing equipment enclosures.

C. Install trim plumb.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

B. Related Sections include the following:
   1. Division 26 Section "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. EPDM: Ethylene-propylene-diene terpolymer rubber.

C. FMC: Flexible metal conduit.

D. IMC: Intermediate metal conduit.

E. LFMC: Liquidtight flexible metal conduit.

F. NBR: Acrylonitrile-butadiene rubber.

G. RNC: Rigid nonmetallic conduit.

H. RMC: Rigid metallic conduit.

1.4 SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, hinged-cover enclosures, and cabinets.

B. Shop Drawings: For the following raceway components. Include plans, elevations, sections, details, and attachments to other work.
   1. Custom enclosures and cabinets.

C. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
   1. Structural members in the paths of conduit groups with common supports.
   2. HVAC and plumbing items and architectural features in the paths of conduit groups with common supports.
   3. Light fixtures, fire suppression system and partition assemblies.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Allied Tube & Conduit; a Tyco International Ltd. Co.
   2. Anamet Electrical, Inc.; Anaconda Metal Hose.
   3. Maverick Tube Corporation.
   4. O-Z Gedney; a unit of General Signal.
   5. Wheatland Tube Company.
   6. Cole-Flex Corp.
   7. Flexcon, Inc.; Coleman Cable Systems, Inc.
   8. LTV Steel Tubular Products Co.
   9. Triangle PWC, Inc.
   10. Or approved equal.

B. Rigid Steel Conduit: ANSI C80.1.

C. IMC: ANSI C80.6.

D. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.
   1. Comply with NEMA RN 1.
   2. Coating Thickness: 0.040 inch (1 mm), minimum.

E. EMT: ANSI C80.3.

F. FMC: Zinc-coated steel.

G. LFMC: Flexible steel conduit with PVC jacket.

H. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.
   1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.
   2. Fittings for EMT: Steel, set-screw or compression type.
   3. Coating for Fittings for PVC-Coated Conduit: Minimum thickness, 0.040 inch (1 mm), with overlapping sleeves protecting threaded joints.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

I. Joint Compound for Rigid Steel Conduit or IMC: Listed for use in cable connector assemblies, and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

2.2 NONMETALLIC CONDUIT AND TUBING

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. CANTEX Inc.
2. CertainTeed Corp.; Pipe & Plastics Group.
3. Condux International, Inc.
4. ElecSYS, Inc.
5. Lamson & Sessions; Carlon Electrical Products.
6. RACO; a Hubbell Company.
7. Thomas & Betts Corporation.
8. George-Ingraham Corp.
9. Georgia Pipe.
10. Or approved equal.

B. RNC: NEMA TC 2, Type EPC-40-PVC, unless otherwise indicated.

C. Fittings for RNC: NEMA TC 3; match to conduit or tubing type and material.

2.3 METAL WIREWAYS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Cooper B-Line, Inc.
2. Hoffman.
3. Square D; Schneider Electric.
4. Keystone/Rees, Inc.
5. Or approved equal.

B. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type 12 indoors, dry, and non-hazardous areas; NEMA 4X in corrosive or outdoor locations and NEMA 7 and 9 in hazardous locations, unless otherwise indicated.

C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireway Covers: Screw-cover type.

E. Finish: Manufacturer's standard enamel finish.

2.4 BOXES, ENCLOSURES, AND CABINETS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
2. EGS/Appleton Electric.
3. Erickson Electrical Equipment Company.
4. Hoffman; a Pentair Company.
5. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
6. O-Z/Gedney; a unit of General Signal.
7. RACO; a Hubbell Company.
8. Robroy Industries, Inc.; Enclosure Division.
9. Spring City Electrical Manufacturing Company.
10. Thomas & Betts Corporation.
11. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.
12. Lamson & Sessions; Carlon Electrical Products.
13. Quazite/Strongwell.
14. Or approved equal.

B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.

C. Cast-Metal Outlet and Device Boxes: NEMA FB 1, ferrous alloy, Type FD, with gasketed cover, except Type FS conduit body where used for exterior devices indicated as weatherproof on drawings.

D. Nonmetallic Outlet and Device Boxes: NEMA OS 2.

E. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

F. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, galvanized, cast iron with gasketed cover.

G. Cast Metal Boxes for Outdoor and Wet Location Installations: NEMA 250; Type 4 and Type 6, flat-flanged, surface-mounted junction box, UL listed as raintight. Galvanized cast iron or cast aluminum box and cover with ground flange, neoprene gasket, and stainless steel cover screws (provide PVC coated as indicated).

H. Cast Metal Boxes for Underground Installations: NEMA 250; Type 4, inside flanged, recessed cover box for flush mounting, UL listed as raintight. Galvanized cast iron box and plain cover with neoprene gasket and stainless steel cover screws.

I. Cabinets:
   1. NEMA 250, Type 1 in indoor, dry locations, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
   2. Hinged door in front cover with flush latch and concealed hinge.
   3. Key latch to match panelboards.
   4. Metal barriers to separate wiring of different systems and voltage.
   5. Accessory feet where required for freestanding equipment.

J. Specialty size backboxes for low-voltage systems shall be provided by others and installed by this Contractor.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2.5 SLEEVES FOR RACEWAYS

A. Steel Pipe Sleeves Above Grade: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves Below Grade: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

C. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.052- or 0.138-inch (1.3- or 3.5-mm) thickness as indicated and of length to suit application.

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07.

2.6 SLEEVE SEALS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Advance Products & Systems, Inc.
2. Calpico, Inc.
3. Metraflex Co.
4. Pipeline Seal and Insulator, Inc.
5. Or approved equal.

B. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.
1. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
2. Pressure Plates: Stainless steel. Include two for each sealing element.
3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Refer to National Electrical Code, Article 100, for the definition of Service Entrance, Feeder, and Branch Circuits.

B. Exterior Feeders, Underground: Use Schedule 40 RNC.

C. Interior Feeders: Use RMC or IMC. Use PVC coated conduit, fittings and hardware where corrosive areas are indicated. Schedule 40 RNC may be used under slabs on grade when covered by a minimum of 4 inches of concrete slab. Schedule 80 shall be used if RNC is used for emergency interior feeders.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

D. Interior Branch Circuits: Use RMC or IMC where exposed and in unfinished areas. Use PVC coated conduit, fittings and hardware where corrosive areas are indicated. Use EMT where conduit is concealed overhead or in wall partitions. Schedule 40 RNC may be used in slabs on grade when covered by a minimum of 4" of concrete slab.

E. Exterior Branch Circuits Underground: Use RMC, IMC, or Schedule 40 RNC. Install a minimum of 24 inches below grade. Use Schedule 80 RNC where installed under pavement.

F. Exterior Feeders and Branch Circuits Exposed Exterior or in Wet Interior Locations: Use RMC or IMC.

G. Use FMC for final connections to motors, transformers, and all other vibrating equipment. Use FMC for final connections to light fixtures installed in or on suspended ceilings. Use LFMC for these type connections outside or where subject to moisture.

H. Use RMC or IMC for conduits used to support pendant mounted light fixtures.

I. Telephone Service Entrance: Use Schedule 40 RNC or IMC.

J. EMT shall not be installed below grade or embedded in concrete.

K. Systems Conduits: Where conduits are required by Contract Documents, use same materials as branch circuits conduits for the conditions itemized above. Systems conduits include but are not limited to Fire Alarm, Data, Instrumentation, and Control systems.

L. All conduit installed in hazardous locations as defined in Article 500 of the National Electrical Code: Use RMC or IMC with explosion-proof fittings. This shall include all wiring in access areas to underground fuel tanks.

M. Indoor Boxes in Dry Finished Office Areas: NEMA 250, Type 1.

N. Indoor Boxes in Dry, Unfinished Corrosive Areas: NEMA 12.

O. Outdoor or Areas Subject to Moisture Boxes and Corrosion: Use NEMA 250, Type 4X.

P. Minimum Raceway Size: 3/4-inch trade size except for FMC enclosing tap conductors from the fixture terminal connection of flush and recessed light fixtures to its outlet box (fixture tails) in accordance with NEC 2002 Article 410, which may be 3/8-inch minimum. Pre-manufactured fixture whips shall be acceptable provided proper wire coloring is maintained. Exterior conduits shall be one-inch minimum size, unless otherwise noted.

3.2 RACEWAY INSTALLATION

A. Maintain minimum six-inch clearance between raceways and piping. Keep raceways at least 12 inches(300 mm) away from parallel runs and at least 6 inches (153mm) away from perpendicular runs of flues generator exhaust and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Cut raceway square using a saw or pipecutter; deburr cut ends.

C. Bring raceway to the shoulder of fittings and couplings and fasten securely.

D. Complete raceway installation before starting conductor installation.

E. Support raceways as specified in Division 26.

F. Install temporary closures to prevent foreign matter from entering raceways.

G. Protect stub-ups from damage where raceways rise through floor slabs. Arrange so curved portions of bends are not visible above the finished slab.

H. Make bends and offsets so interior diameter is not reduced. Keep legs of bends in the same plane and keep straight legs of offsets parallel, unless otherwise indicated.

I. Conceal raceways within finished walls, ceilings, and floors, in finished office areas, unless otherwise indicated.
   1. Install concealed raceways with a minimum of bends in the shortest practical distance, considering type of building construction and obstructions, unless otherwise indicated.

J. Raceways Embedded in Elevated Slabs: No conduit allowed in elevated slabs.

K. Install exposed raceways parallel or at right angles to nearby surfaces or structural members and follow surface contours as much as possible.
   1. Run parallel or banked raceways together on common supports.
   2. Make parallel bends in parallel or banked runs. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.

L. Join raceways with fittings designed and approved for that purpose and make joints tight.
   1. Use insulating bushings to protect conductors in all branch circuits.
   2. Use bonding bushings or wedges at connections subject to vibration.

M. Tighten set screws of threadless fittings with suitable tools.

N. Avoid moisture traps where possible; where unavoidable, provide junction box with drain fitting at conduit low point.

O. Install expansion joint fittings where raceway crosses building expansion, seismic or control joints. Provide bonding jumper wire across expansion joint fittings.

P. RMC or IMC installed underground for feeders shall be coated with two coats of asphaltum where not encased in concrete.

Q. Raceways crushed or deformed in bending shall be rejected.

R. In general, raceway layout on the drawings is diagrammatic. Follow layout where possible, but where changes are necessary due to structural conditions, other apparatus, or other causes, make them. Offsets in raceways are not indicated; furnish as required.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

S. Provide bonding busings on all feeders.

T. Terminations:
1. Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against box. Use two locknuts, one inside and one outside box.
2. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into hub so end bears against wire protection shoulder. Where chase nipples are used, align raceways so coupling is square to box; tighten chase nipple so no threads are exposed.

U. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb(90-kg) tensile strength. Leave at least 12 inches(300 mm) of slack at each end of pull wire.

V. Signal System Raceways, 2-Inch Trade Size and Smaller: In addition to above requirements, install raceways in maximum lengths of 150 feet(45 m) and with a maximum of two 90-degree bends or equivalent. Separate lengths with pull or junction boxes where necessary to comply with these requirements. Size boxes per NFPA 70 Article 314.28, 2005 Edition.

W. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
1. Where raceways pass from hazardous to non-hazardous locations.
2. Where otherwise required by NFPA 70.

X. Stub-up Connections: Extend raceways through concrete floor for connection to freestanding equipment. Extend conductors to equipment with LFMC beginning a minimum of 6 inches(150 mm) above the floor.

Y. Flexible Connections: Use maximum of 72 inches(1830 mm) of FMC final connection to recessed and semi-recessed lighting fixtures. Use maximum of 72 inch LFMC for final connection to equipment subject to vibration, noise transmission, or movement; and all motors. Install separate grounding conductor across flexible connections.

Z. Use conduit hubs for fastening raceway to cast boxes and for fastening raceway to sheet metal boxes in damp or wet locations.

AA. There shall not be more than the equivalent of four 90-degree bends between pull points; e.g., raceway bodies and boxes. Provide pull or junction boxes in raceway runs, spaced a maximum of 200 feet between boxes.

BB. Surface Raceways: Install a separate, green, ground conductor in raceways from junction box supplying raceways to receptacle or fixture ground terminals.

CC. Raceways Embedded in Grade-Level Slabs: Underfloor conduits at slab on grade shall be run in earth below slab with minimum depth of 12 inches (305mm) below bottom of slab.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1. Transition from nonmetallic tubing to RSC or IMC before rising above top of slab.
2. Provide (2) coats of asphaltum on conduit.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:
   1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Division 31 Section "Site Excavation, Backfilling, and Compaction" for pipe less than 6 inches (150 mm) in nominal diameter.
   2. Install backfill as specified in Division 31 Section "Site Excavation, Backfilling, and Compaction".
   3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches (300 mm) of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Division 31 Section "Site Excavatin, Backfilling, and Compaction."
   4. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
      a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete.
      b. For stub-ups at equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.
   5. Warning Planks: Bury warning planks approximately 12 inches (300 mm) above direct-buried conduits, placing them 24 inches (600 mm) o.c. Align planks along the width and along the centerline of conduit.

3.4 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07.

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Rectangular Sleeve Minimum Metal Thickness:
   1. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and no side greater than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
   2. For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches (1270 mm) and 1 or more sides equal to, or greater than, 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

E. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

F. Cut sleeves to length for mounting flush with both surfaces of walls.

G. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level.

H. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway unless sleeve seal is to be installed.

I. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.

J. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway, using joint sealant appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.

K. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway penetrations. Install sleeves and seal with firestop materials. Comply with Division 07.

L. Roof-Penetration Sleeves: Seal penetration of individual raceways with flexible, boot-type flashing units applied in coordination with roofing work.

M. Aboveground, Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

N. Underground, Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between raceway and sleeve for installing mechanical sleeve seals.

3.5 SLEEVE-SEAL INSTALLATION

A. Install to seal underground, exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for raceway material and size. Position raceway in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.6 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3.7 BOX APPLICATIONS

A. Provide electrical boxes as shown on the drawings, and as required for splices, taps, wire pulling, equipment connections, and code compliance.
   1. Electrical box locations shown on Contract Documents are approximate unless dimensioned. Verify exact location of floor boxes and outlets in offices and work areas prior to rough-in.
   2. Locate and install boxes to allow access. Where installation is inaccessible, coordinate locations and sizes of required access doors with applicable Sections of these Specifications.
   3. Locate and install to maintain headroom and to present a neat appearance.

B. Do not install boxes back-to-back in walls. Provide minimum six-inch separation, except provide minimum 24-inch separation in acoustic-rated walls and fire- and/or smoke-rated walls. In fire- and/or smoke-rated walls, the surface area of individual metallic outlet boxes shall not exceed 16 square inches in each and the aggregate surface areas of the boxes shall not exceed 100 square inches per 100 square feet of wall area. Where these limitations are exceeded, boxes shall be wrapped with Type "X", 5/8-inch, fire-rated gypsum board to maintain wall rating.

C. Locate boxes in masonry walls to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat openings of boxes.

D. Provide knock-out closures for unused box openings.

E. Support boxes independently of raceway except for cast boxes that are connected to two rigid metal raceways, both supported within 12 inches of box. Support ceiling boxes directly from structure per Division 26. Support wall boxes by attaching directly to wall studs.

F. Use multiple-gang boxes where more than one device is mounted together; do not use sectional boxes. Provide permanent barriers to separate wiring of different voltage systems. Provide permanent barriers between wall switches controlling switches on different phases of 480Y/277 volt systems and to separate wiring of normal and emergency power systems.

G. Install boxes without damaging wall insulation.

H. Coordinate mounting heights and locations of outlets mounted above counters, benches, and backsplashes with Architectural elevations.

I. Coordinate mounting heights and locations of outlets, mounted below, in, or around built-in casework, with the casework supplier, Contractor, and Architect.

J. Position outlets to locate luminaries as shown on the reflected ceiling plans on drawings.

K. Provide recessed outlet boxes in finished areas; secure boxes to interior wall and partition studs, accurately positioning to allow for surface finish thickness. Use stamped steel stud bridges for flush outlets in hollow stud wall, and adjustable steel channel fasteners for flush ceiling outlet boxes.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

L. Align the heart of wall-mounted outlet boxes for switches, thermostats, and similar devices.

M. Locate pull boxes and junction boxes above accessible ceilings or in unfinished areas.

N. Support pull and junction boxes independent of conduit.

O. Install hinged-cover enclosures and cabinets plumb. Support at each corner.

3.8 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
   1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
   2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.9 CLEANING

A. After completing installation of exposed, factory-finished raceways and boxes, inspect exposed finishes and repair damaged finishes.

B. Remove all debris from boxes before installing devices and service fittings.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Conduit, ducts, and duct accessories for direct-buried and concrete-encased duct banks.
   2. Handholes and boxes.
   3. Manholes.

1.3 DEFINITION

A. RNC: Rigid nonmetallic conduit.

1.4 SUBMITTALS

A. Product Data: For the following:
   1. Duct-bank materials, including separators and miscellaneous components.
   2. Ducts and conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
   3. Accessories for manholes, handholes, and boxes.
   4. Warning tape.
   5. Warning planks.

B. Shop Drawings for Precast or Factory-Fabricated Underground Utility Structures: Include plans, elevations, sections, details, attachments to other work, and accessories, including the following:
   1. Duct entry provisions, including locations and duct sizes.
   2. Reinforcement details.
   3. Frame and cover design and manhole frame support rings.
   4. Ladder details.
   5. Grounding details.
   6. Dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.
   7. Joint details.

C. Product Certificates: For concrete and steel used in precast concrete manholes and handholes, as required by ASTM C 858.

D. Qualification Data: For professional engineer and testing agency.

E. Source quality-control test reports.

F. Field quality-control test reports.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1.5 QUALITY ASSURANCE

A. Comply with ANSI C2.

B. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver ducts to Project site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.

B. Store precast concrete underground utility structures at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.

C. Lift and support precast concrete units only at designated lifting or supporting points.

1.7 PROJECT CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
   1. Notify Engineer, Construction Manager, and Owner no fewer than 30 days in advance of proposed interruption of electrical service.
   2. Do not proceed with interruption of electrical service without Construction Manager's and Owner's written permission.

1.8 COORDINATION

A. Coordinate layout and installation of ducts, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field.

B. Coordinate elevations of ducts and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of ducts and duct banks as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations from those indicated as required to suit field conditions and to ensure that duct runs drain to manholes and handholes, and as approved by the Engineer.

1.9 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

B. Furnish cable-support stanchions, arms, insulators, and associated fasteners in quantities equal to 5 (no less than one) percent of quantity of each item installed.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 2 - PRODUCTS

2.1 CONDUIT

A. Rigid Steel Conduit: Galvanized. Comply with ANSI C80.1.

B. RNC: NEMA TC 2, Type EPC-40-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

2.2 NONMETALLIC DUCTS AND DUCT ACCESSORIES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. ARNCO Corp.
2. Beck Manufacturing.
3. Cantex, Inc.
4. CertainTeed Corp.; Pipe & Plastics Group.
5. Condux International, Inc.
6. ElecSys, Inc.
7. Electri-Flex Company.
8. IPEX Inc.
9. Lamson & Sessions; Carlon Electrical Products.
10. Spiraduct/AFC Cable Systems, Inc.
11. Or approved equal.

B. Underground Plastic Utilities Duct: NEMA TC 6 & 8, Type EB-20-PVC, ASTM F 512, UL 651A, with matching fittings by the same manufacturer as the duct, complying with NEMA TC 9.

C. Duct Accessories:
1. Duct Separators: Factory-fabricated rigid PVC interlocking spacers, sized for type and sizes of ducts with which used, and selected to provide minimum duct spacings indicated while supporting ducts during concreting or backfilling.
2. Warning Tape: Underground-line warning tape specified in Division 26 Section "Identification for Electrical Systems."
3. Concrete Warning Planks: Nominal 12 by 24 by 3 inches (300 by 600 by 76 mm) in size, manufactured from 6000-psi (41-MPa) concrete.
   a. Color: Red dye added to concrete during batching.
   b. Mark each plank with "ELECTRIC" in 2-inch- (50-mm-) high, 3/8-inch- (10-mm-) deep letters.

2.3 PRECAST CONCRETE HANDHOLES AND BOXES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Carder Concrete Products.
2. Christy Concrete Products.
3. Elmhurst-Chicago Stone Co.
4. Oldcastle Precast Group.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

5. Riverton Concrete Products; a division of Cretex Companies, Inc.
6. Utility Concrete Products, LLC.
7. Utility Vault Co.
8. Wausau Tile, Inc.
9. Or approved equal.

B. Comply with ASTM C 858 for design and manufacturing processes.

C. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.
1. Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
2. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
3. Cover Legend: Molded lettering, "ELECTRIC" or "DATA" on the Drawings.
4. Configuration: Units shall be designed for flush burial and have open bottom, unless otherwise indicated.
5. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches (300 mm) vertically and horizontally to accommodate alignment variations.
   a. Windows shall be located no less than 6 inches (150 mm) from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.
   b. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
   c. Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.
6. Handholes: Medium-sized, 12 inches wide by 24 inches long (300 mm wide by 600 mm long) and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.4 PRECAST MANHOLES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Carder Concrete Products.
2. Christy Concrete Products.
3. Elmhurst-Chicago Stone Co.
4. Oldcastle Precast Group.
5. Riverton Concrete Products; a division of Cretex Companies, Inc.
6. Utility Concrete Products, LLC.
7. Utility Vault Co.
8. Wausau Tile, Inc.
9. Or approved equal.

B. Comply with ASTM C 858, with structural design loading as specified in Part 3 "Underground Enclosure Application" Article and with interlocking mating sections, complete with accessories, hardware, and features.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches (300 mm) vertically and horizontally to accommodate alignment variations.
   a. Windows shall be located no less than 6 inches (150 mm) from interior surfaces of walls, floors, or roofs of manholes, but close enough to corners to facilitate racking of cables on walls.
   b. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
   c. Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.

C. Concrete Knockout Panels: 1-1/2 to 2 inches (38 to 50 mm) thick, for future conduit entrance and sleeve for ground rod.

D. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

2.5 UTILITY STRUCTURE ACCESSORIES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Bilco Company (The).
2. Carder Concrete Products.
3. Elmhurst-Chicago Stone Co.
4. McKinley Iron Works, Inc.
5. Neenah Foundry Company.
6. Oldcastle Precast Group.
7. Osburn Associates, Inc.
8. Pennsylvania Insert Corporation.
9. Strongwell Corporation; Lenoir City Division.
10. Underground Devices, Inc.
11. Utility Concrete Products, LLC.
12. Utility Vault Co.
13. Wausau Tile, Inc.
14. Or approved equal.

B. Manhole Frames, Covers, and Chimney Components: Comply with structural design loading specified for manhole.
1. Frame and Cover: Weatherproof, gray cast iron complying with ASTM A 48/A 48M, Class 30B with milled cover-to-frame bearing surfaces; diameter, 26 inches (660 mm).
   a. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
   b. Special Covers: Recess in face of cover designed to accept finish material in paved areas.
2. Cover Legend: Cast in. Selected to suit system.
   a. Legend: "ELECTRIC-LV" for duct systems with power wires and cables for systems operating at 600 V and less.
   b. Legend: "SIGNAL" for communications, data, and telephone duct systems.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3. Manhole Chimney Components: Precast concrete rings with dimensions matched to those of roof opening.
   a. Mortar for Chimney Ring and Frame and Cover Joints: Comply with ASTM C 270, Type M, except for quantities less than 2.0 cu. ft. (60 L) where packaged mix complying with ASTM C 387, Type M, may be used.

C. Pulling Eyes in Concrete Walls: Eyebolt with reinforcing-bar fastening insert, 2-inch- (50-mm-) diameter eye, and 1-by-4-inch (25-by-100-mm) bolt.
   1. Working Load Embedded in 6-Inch (150-mm), 4000-psi (27.6-MPa) Concrete: 13,000-lbf (58-kN) minimum tension.

D. Bolting Inserts for Concrete Utility Structure Cable Racks and Other Attachments: Flared, threaded inserts of noncorrosive, chemical-resistant, nonconductive thermoplastic material; 1/2-inch (13-mm) ID by 2-3/4 inches (69 mm) deep, flared to 1-1/4 inches (32 mm) minimum at base.
   1. Tested Ultimate Pullout Strength: 12,000 lbf (53 kN) minimum.

E. Expansion Anchors for Installation after Concrete Is Cast: Zinc-plated, carbon-steel-wedge type with stainless-steel expander clip with 1/2-inch (13-mm) bolt, 5300-lbf (24-kN) rated pullout strength, and minimum 6800-lbf (30-kN) rated shear strength.

F. Cable Rack Assembly: Nonmetallic. Components fabricated from nonconductive, fiberglass-reinforced polymer.
   1. Stanchions: Nominal 36 inches (900 mm) high by 4 inches (100 mm) wide, with minimum of 9 holes for arm attachment.
   2. Arms: Arranged for secure, drop-in attachment in horizontal position at any location on cable stanchions, and capable of being locked in position. Arms shall be available in lengths ranging from 3 inches (75 mm) with 450-lb (204-kg) minimum capacity to 20 inches (508 mm) with 250-lb (114-kg) minimum capacity. Top of arm shall be nominally 4 inches (100 mm) wide, and arm shall have slots along full length for cable ties.

G. Duct-Sealing Compound: Nonhardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 deg F (2 deg C). Capable of withstanding temperature of 300 deg F (150 deg C) without slump and adhering to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.

H. Portable Manhole Ladders: UL-listed, heavy-duty fiberglass specifically designed for portable use for access to electrical manholes. Minimum length equal to distance from deepest manhole floor to grade plus 36 inches (900 mm). Two required.

I. Cover Hooks: Heavy duty, designed for lifts 60 lbf (270 N) and greater. Two required.

2.6 SOURCE QUALITY CONTROL

A. Test and inspect precast concrete utility structures according to ASTM C 1037.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1. Strength tests of complete boxes and covers shall be by either an independent testing agency or the manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
2. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 UNDERGROUND DUCT APPLICATION

A. Ducts for Electrical Feeders 600 V and Less: RNC**,** NEMA Type EPC-40-PVC, in concrete-encased duct bank, unless otherwise indicated on drawings.

B. Ducts for Electrical Branch Circuits: RNC, NEMA Type EPC-40-PVC, in concrete-encased duct bank, unless otherwise indicated on drawings.

C. Underground Ducts for Telephone, Communications, or Data Utility Service Cables: RNC, NEMA Type EPC-40-PVC, in concrete-encased duct bank, unless otherwise indicated on drawings.

D. Underground Ducts Crossing Driveways and Roadways: RNC, NEMA Type EPC-40-PVC, encased in reinforced concrete.

3.2 UNDERGROUND ENCLOSURE APPLICATION

A. Handholes and Boxes for 600 V and Less, Including Telephone, Communications, and Data Wiring:
   1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete. AASHTO HB 17, H-20 structural load rating.
   2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Precast concrete, AASHTO HB 17, H-20 structural load rating.
   3. Units in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Precast concrete, AASHTO HB 17, H-10 structural load rating.

B. Manholes: Precast concrete.
   1. Units Located in Roadways and Other Deliberate Traffic Paths by Heavy or Medium Vehicles: H-20 structural load rating according to AASHTO HB 17.
   2. Units Not Located in Deliberate Traffic Paths by Heavy or Medium Vehicles: H-10 load rating according to AASHTO HB 17.

3.3 EARTHWORK

A. Excavation and Backfill: Comply with Division 31 Section "Site Excavation, Backfilling, and Compaction," but do not use heavy-duty, hydraulic-operated, compaction equipment.

B. Cut and patch existing pavement in the path of underground ducts and utility structures according to Division 01 Section "Cutting and Patching."

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3.4 DUCT INSTALLATION

A. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes to drain in both directions.

B. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48 inches (1220 mm), both horizontally and vertically, at other locations, unless otherwise indicated.

C. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.

D. Duct Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches (250 mm) o.c. for 5-inch (125-mm) ducts, and vary proportionately for other duct sizes.
   1. Begin change from regular spacing to end-bell spacing 10 feet (3 m) from the end bell without reducing duct line slope and without forming a trap in the line.
   2. Direct-Buried Duct Banks: Install an expansion and deflection fitting in each conduit in the area of disturbed earth adjacent to manhole or handhole.
   3. Grout end bells into structure walls from both sides to provide watertight entrances.

E. Building Wall Penetrations: Make a transition from underground duct to rigid steel conduit at least 10 feet (3 m) outside the building wall without reducing duct line slope away from the building, and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition. Install conduit penetrations of building walls as specified in Division 26 Section "Common Work Results for Electrical."

F. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig (1.03-MPa) hydrostatic pressure.

G. Pulling Cord: Install 100-lbf- (445-N-) test nylon cord in ducts, including spares.

H. Concrete-Encased Ducts: Support ducts on duct separators.
   1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than five spacers per 20 feet (6 m) of duct. Secure separators to earth and to ducts to prevent floating during concreting. Stagger separators approximately 6 inches (150 mm) between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
   2. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.
      a. Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written recommendations, or use other specific measures to prevent expansion-contraction damage.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch (19-mm) reinforcing rod dowels extending 18 inches (450 mm) into concrete on both sides of joint near corners of envelope.

3. Pouring Concrete: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.
4. Reinforcement: Reinforce concrete-encased duct banks where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
5. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
6. Minimum Space between Ducts: 3 inches (75 mm) between ducts and exterior envelope wall, 2 inches (50 mm) between ducts for like services, and 4 inches (100 mm) between power and signal ducts.
7. Depth: Install top of duct bank at least 24 inches (600 mm) below finished grade in areas not subject to deliberate traffic, and at least 30 inches (750 mm) below finished grade in deliberate traffic paths for vehicles, unless otherwise indicated.
8. Stub-Ups: Use manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
   a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete.
   b. Stub-Ups to Equipment: For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of base. Install insulated grounding bushings on terminations at equipment.
9. Warning Tape: Bury warning tape approximately 12 inches (300 mm) above all concrete-encased ducts and duct banks. Align tape parallel to and within 3 inches (75 mm) of the centerline of duct bank. Provide an additional warning tape for each 12-inch (300-mm) increment of duct-bank width over a nominal 18 inches (450 mm). Space additional tapes 12 inches (300 mm) apart, horizontally.

I. Direct-Buried Duct Banks:
1. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.
2. Space separators close enough to prevent sagging and deforming of ducts, with not less than five spacers per 20 feet (6 m) of duct. Secure separators to earth and to ducts to prevent displacement during backfill and yet permit linear duct movement due to expansion and contraction as temperature changes. Stagger spacers approximately 6 inches (150 mm) between tiers.
3. Excavate trench bottom to provide firm and uniform support for duct bank. Prepare trench bottoms as specified in Division 31 Section "Site Excavation, Backfilling, and Compaction" for pipes less than 6 inches (150 mm) in nominal diameter.
4. Install backfill as specified in Division 31 Section "Site Excavation, Backfilling, and Compaction".
5. After installing first tier of ducts, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

each tier. After placing last tier, hand-place backfill to 4 inches (100 mm) over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction as specified in Division 31 Section "Site Excavation, Backfilling, and Compaction".

6. Install ducts with a minimum of 3 inches (75 mm) between ducts for like services and 6 inches (150 mm) between power and signal ducts.
7. Depth: Install top of duct bank at least 36 inches (900 mm) below finished grade, unless otherwise indicated on drawings.
8. Set elevation of bottom of duct bank below the frost line.
9. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
    a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete.
    b. For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.
10. Warning Planks: Bury warning planks approximately 12 inches (300 mm) above direct-buried ducts and duct banks, placing them 24 inches (600 mm) o.c. Align planks along the width and along the centerline of duct bank. Provide an additional plank for each 12-inch (300-mm) increment of duct-bank width over a nominal 18 inches (450 mm). Space additional planks 12 inches (300 mm) apart, horizontally.

3.5 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

A. Precast Concrete Handhole and Manhole Installation:
1. Comply with ASTM C 891, unless otherwise indicated.
2. Install units level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.
3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch (25-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.

B. Elevations:
1. Manhole Roof: Install with rooftop at least 15 inches (380 mm) below finished grade.
2. Manhole Frame: In paved areas and trafficways, set frames flush with finished grade. Set other manhole frames 1 inch (25 mm) above finished grade.
3. Install handholes with bottom below the frost line.
4. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch (25 mm) above finished grade.
5. Where indicated, cast handhole cover frame integrally with handhole structure.

C. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.

D. Manhole Access: Circular opening in manhole roof; sized to match cover size.
1. Manholes with Fixed Ladders: Offset access opening from manhole centerlines to align with ladder.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2. Install chimney, constructed of precast concrete collars and rings to support frame and cover and to connect cover with manhole roof opening. Provide moisture-tight masonry joints and waterproof grouting for cast-iron frame to chimney.

E. Waterproofing: Apply waterproofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. Waterproofing materials and installation are specified in Division 07 Section "Elastomeric Sheet Waterproofing." After ducts have been connected and grouted, and before backfilling, waterproof joints and connections and touch up abrasions and scars. Waterproof exterior of manhole chimneys after mortar has cured at least three days.

F. Hardware: Install removable hardware, including pulling eyes, cable stanchions, and cable arms, as required for installation and support of cables and conductors and as indicated.

G. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8 inches (98 mm) for manholes and 2 inches (50 mm) for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.

H. Warning Sign: Install "Confined Space Hazard" warning sign on the inside surface of each manhole cover.

3.6 GROUNDING

A. Ground underground ducts and utility structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."

3.7 FIELD QUALITY CONTROL

A. Perform the following tests and inspections and prepare test reports:
1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.
2. Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.
3. Test manhole and handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Correct deficiencies and retest as specified above to demonstrate compliance.

3.8 CLEANING

A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

B. Clean internal surfaces of manholes, including sump. Remove foreign material.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
1. Identification for raceway and metal-clad cable.
2. Identification for conductors and communication and control cable.
3. Underground-line warning tape.
4. Warning labels and signs.
5. Instruction signs.
6. Equipment identification labels.
7. Miscellaneous identification products.

1.3 SUBMITTALS

A. Product Data: For each electrical identification product indicated.

B. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.

C. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.

1.4 QUALITY ASSURANCE

A. Comply with ANSI A13.1 and ANSI C2.

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.145.

1.5 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in the Contract Documents, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual, and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

C. Coordinate installation of identifying devices with location of access panels and doors.

D. Install identifying devices before installing acoustical ceilings and similar concealment.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 2 - PRODUCTS

2.1 RACEWAY AND METAL-CLAD CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

B. Color for Printed Legend:
   1. Power Circuits: Black letters on an orange field.
   2. Legend: Indicate service and voltage.

C. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

D. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 inches (50 mm) wide; compounded for outdoor use.

2.2 CONDUCTOR AND COMMUNICATION- AND CONTROL-CABLE IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide.

B. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

2.3 UNDERGROUND-LINE WARNING TAPE

A. Description: Permanent, bright-colored, continuous-printed, polyethylene tape.
   1. Not less than 6 inches (150 mm) wide by 4 mils (0.102 mm) thick.
   2. Compounded for permanent direct-burial service.
   3. Embedded continuous metallic strip or core.
   4. Printed legend shall indicate type of underground line.

2.4 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Self-Adhesive Warning Labels: Factory printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment, unless otherwise indicated.

C. Metal-Backed, Butyrate Warning Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch (1-mm) galvanized-steel backing; and with colors, legend, and size required for application. 1/4-inch (6.4-mm) grommets in corners for mounting. Nominal size, 10 by 14 inches (250 by 360 mm).

D. Warning label and sign shall include, but are not limited to, the following legends:

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR _____ INCHES." Where inches are as defined in NEC working clearances.
3. Emergency Power Sources: "GENERATOR(S) SUPPLY POWER TO THIS FACILITY AND ARE LOCATED _____". Mount at service entrance equipment.

2.5 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch (1.6 mm) thick for signs up to 20 sq. in. (129 sq. cm) and 1/8 inch (3.2 mm) thick for larger sizes.
1. Engraved legend with black letters on white face.
2. Punched or drilled for mechanical fasteners.
3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.6 EQUIPMENT IDENTIFICATION NAMEPLATES

A. Engraved, Laminated Three (3) Layer Acrylic or Melamine Label: Punched or drilled for screw mounting.
1. Power – White letters on a black background.
2. Fire Alarm Cabinets – White letters on a red background.
3. Transfer switches are to be labeled per emergency power.

2.7 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Cable Ties: Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties.
1. Minimum Width: 3/16 inch (5 mm).
2. Tensile Strength: 50 lb (22.6 kg), minimum.
3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
4. Color: Black, except where used for color-coding.

B. Paint: Paint materials and application requirements are specified in Division 09 painting Sections.

C. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 APPLICATION

A. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30 A: Identify with orange self-adhesive vinyl label.
1. Normal Power – White letters on a black background.
2. Fire Alarm Cabinets – White letters on a red background.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Power-Circuit Conductor Identification: For secondary conductors No. 4 AWG and larger in vaults, pull and junction boxes, manholes, and handholes use color-coding conductor tape. Identify source and circuit number of each set of conductors. For single conductor cables, identify phase in addition to the above.

C. Branch-Circuit Conductor Identification: Provide wire markers on each conductor in panelboard gutters, pull and junction boxes identifying the branch circuit for all power and lighting circuits.

D. Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source and circuit number.

E. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, signal, sound, intercommunications, voice, and data connections.
   1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
   2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
   3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and Operation and Maintenance Manual.

F. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable. Install underground-line warning tape for both direct-buried cables and cables in raceway.

G. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145 and apply self-adhesive warning labels. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.
   1. Equipment with Multiple Power or Control Sources: Apply to door or cover of equipment including, but not limited to, the following:
      a. Power transfer switches.
      b. Controls with external control power connections.
   2. Equipment Requiring Workspace Clearance According to NFPA 70: Unless otherwise indicated, apply to door or cover of equipment but not on flush panelboards and similar equipment in finished spaces.

H. Instruction Signs:
   1. Operating Instructions: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.
   2. Emergency Operating Instructions: Install instruction signs with white legend on a red background with minimum 3/8-inch- (10-mm-) high letters for emergency instructions at equipment used for power transfer.

I. Equipment Identification Nameplates: On each unit of equipment, install unique designation nameplate that is consistent with wiring diagrams, schedules, and Operation and Maintenance Manual. Apply nameplates to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

J. Provide nameplates of minimum letter height with the required information as indicated below.

K. Panelboards, Switchboards and Motor Control Centers: 1/4 inch; identify equipment designation. 1/8 inch; identify voltage rating and source.

L. Individual Circuit Breakers, Switches, and Motor Starters In Power Panelboards, Switchboards, and Motor Control Centers: 1/8 inch; identify circuit and load served, including location. Typed paper labels inserted in manufactured slots shall not be acceptable.

M. Individual Circuit Breakers, Enclosed Fused and Non-Fused Switches, Combination Starters, Variable Speed Drives, and Motor Starters (Including Starters and Control Cabinets Furnished By Others): 1/8 inch; identify circuit and load served.

N. Transformers: 1/4 inch; identify equipment designation. 1/8 inch; identify primary and secondary voltages, primary source, and secondary load and location.

O. Systems Cabinets (Fire Alarm, Instrumentation, etc.): 1/4 inch identifies equipment designation; 1/8 inch identifies circuit supplying the cabinet.

P. Control Devices (Time Clocks, Lighting Contactors, Instrumentation Relay Cabinets, etc.): 1/8 inch identifies equipment designation; 1/8 inch identify circuit load served.

Q. Receptacles Requiring Labels: 1/8 inch identifying panelboard name and circuit number to which receptacle is connected. White letters on black background for normal power and white letters on red background for emergency power circuits.

R. Miscellaneous Signage: 1/4 inch, wording as specified on drawings. White letters on black background unless noted otherwise on the drawings.

S. Degrease and clean surfaces to receive nameplates.

T. Install nameplates parallel, plumb and level to equipment lines.

U. Secure pre-drilled nameplates to equipment fronts using screws or rivets. Adhesive backed labels shall not be acceptable. Secure nameplate to outside face of recessed panelboard doors in finished locations.

3.2 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Apply identification devices to surfaces that require finish after completing finish work.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

D. Attach nonadhesive signs and plastic labels with screws or rivets and auxiliary hardware appropriate to the location and substrate.

3.3 POWER SYSTEM COLOR CODING

A. Color-coding shall be in accordance with NEC Article 700-9(a).

B. Color code all junctions and pull boxes and enclosures for normal power, emergency power, and fire alarm circuits so that they can be readily identified as components of those systems. Paint the entire box and cover. Painting only the cover of the box shall not be acceptable.

C. Color code conduits for power and fire alarm systems with a four-inch band of paint or plastic tape every ten feet minimum and within one foot of any box.

D. Color coding shall be as follows:

Normal Power System	Brown
Fire Alarm System:	Red

E. Color-Coding for Phase and Voltage Level Identification, 600 V and Less: Use the colors listed below for ungrounded service, feeder, and branch-circuit conductors.
1. Color shall be factory applied or, for sizes larger than No. 8 AWG field applied.
2. Colors for 208/120-V Circuits:
   a. Phase A: Black.
   b. Phase B: Red.
   c. Phase C: Blue.
3. Colors for 480/277-V Circuits:
   a. Phase A: Brown.
   b. Phase B: Orange.
   c. Phase C: Yellow.
4. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches (150 mm) from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

F. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches (150 to 200 mm) below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches (400 mm) overall.

3.4 PULL AND JUNCTION BOX LABELING

A. Indicate in legible, permanent black marker the panel and circuit number of all power-wiring conductors contained in the box on the exterior of the box cover. Label cover at floor level. Do not label standing on a ladder with box cover above.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes requirements for power distribution equipment studies.

1.3 SUBMITTALS

A. Preliminary Power System Study: A preliminary power system study shall be submitted along with the power distribution equipment submittal. This study to utilize standard transformer impedance, specified motor data, and Contractor estimated conductor lengths.
   1. Letter from Utility documenting available fault.
   2. Input data report.
   3. Fault Study report.
   4. Coordination-Study report.
   5. Equipment evaluation report.
   6. Setting report including settings for all adjustable breakers (including all Owner-Furnished Equipment).
   7. Arc flash study report.
   8. System one-line diagram.

B. Final Power System Study: A final study based on the approved preliminary power system study shall be submitted prior to providing Arc Flash Warning Signage but after conductors and components are installed. This study to utilize installed transformer impedances, installed motor sizes, and installed conductor lengths. This submittal to include all items listed above under preliminary power system study.

1.4 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.

B. Power System Study Specialist Qualifications: An organization experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices. The study shall be stamped by a Professional Engineer licensed in the projects jurisdiction.

C. Comply with IEEE 399 for general study procedures.

D. Coordinated system of overcurrent devices shall be defined a minimum six-cycle separation of trip curves from 0.1 seconds to 10000 seconds while providing equipment protection. Overlapping of curves in series where interruption of either breaker does not increase system outage will be allowed (i.e., transformer primary and secondary breakers).

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Selection and adjustment of overcurrent devices shall be made to provide coordinated system and minimize arc flash energy.

B. Proceed with study only after relevant equipment submittals have been assembled. Overcurrent protective devices shall not be submitted for approval without an accompanying Study.

3.2 FAULT-CURRENT STUDY

A. Source Impedance and Available Fault: Obtain from Utility with documenting letter.

B. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project and use approved computer software program to calculate values. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.

C. Calculate momentary and interrupting duties on the basis of maximum available fault current. Let thru values for fuses shall not be used in the calculations to reduce the maximum available fault at any point.

D. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with the following:
   1. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.50.
   2. Low-Voltage Fuses: IEEE C37.46.
   3. Circuit Breakers: IEEE C37.13.

E. Study Report: Indicate calculated X/R ratios and interrupting (5-cycle) fault currents on electrical distribution system diagram of the report. List other output values from computer analysis, including momentary (1/2-cycle), interrupting (5-cycle), and 30-cycle fault-current values for 3-phase, single phase-to-ground, phase-to-phase, and phase-to-phase-to-ground faults.

F. Equipment Evaluation Report: Prepare a report on the adequacy of overcurrent protective devices and conductors by comparing fault-current ratings of these devices with calculated fault-current momentary and interrupting duties.

3.3 COORDINATION STUDY

A. Gather and tabulate the following input data to support coordination study:

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1. Product Data for overcurrent protective devices specified in other Division 26 Sections and with all process equipment that is involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
2. Electrical distribution system diagram showing the following:
    a. Circuit-breaker and fuse-current ratings and types.
    b. Relays and associated power and current transformer ratings and ratios.
    c. Transformer, primary and secondary voltages, connection type, impedance, and X/R ratios.
    d. Generator kilovolt amperes, size, voltage, and source impedance.
    e. Cables. Indicate conduit material, sizes of conductors, conductor insulation, and length.
    f. Busway ampacity and impedance.
    g. Motor horsepower and code letter designation according to NEMA MG 1.
3. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram:
    a. Ratings, types, and settings of Utility company's overcurrent protective devices.
    b. Special overcurrent protective device settings or types stipulated by Utility company.
    c. Time-current-characteristic curves of devices indicated to be coordinated.
    d. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, instantaneous adjustment range, and ground fault adjustment range for circuit breakers.
    e. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.

B. Perform coordination study and prepare a written report using the results of fault-current study and approved computer software program. Comply with IEEE 399.

C. Comply with NFPA 70 for overcurrent protection of circuit elements and devices.

D. Transformer Primary Overcurrent Protective Devices:
    1. Device shall protect transformer according to IEEE C57.12.00, for fault currents.

E. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Verify adequacy of phase conductors at maximum three-phase bolted fault currents, equipment grounding conductors, and grounding electrode conductors at maximum ground-fault currents.

F. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:
    1. Tabular Format of Settings Selected for Overcurrent Protective Devices:
        a. Device tag.
        b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
d. Fuse-current rating and type.
e. Ground-fault relay-pickup and time-delay settings.

2. Coordination Curves: Prepare an individual coordination curve for each panelboard, switchboard, switchgear, or motor control center. Each curve shall include the largest overcurrent device in said panelboard, switchboard, switchgear, or motor control center and each overcurrent device in series back to and including the first overcurrent device in the Utility company's system. Include on each curve applicable cable thermal damage curve and transformer damage curve. For each panelboard, switchboard, switchgear, or motor control center also served via a transfer switch by a generator: provide a separate curve from largest breaker in the panelboard, switchboard, switchgear, or motor control center and each overcurrent device in series back to the generator main circuit breaker. Include cable thermal damage curve, transformer damage curve, generator decrement curve, and generator thermal damage curve on each emergency power curve. Show the following specific information:
   a. Device tag.
   b. Voltage and current ratio for curves.
   c. Three-phase and single-phase damage points for each transformer.
   d. No damage, melting, and clearing curves for fuses.
   e. Cable damage curves.
   f. Transformer inrush points.
   g. Maximum fault-current cutoff point.
   h. Generator decrement curve.
   i. Generator thermal-damage curve.
3. Completed data sheets for setting of overcurrent protective devices.

3.4 OVERCURRENT PROTECTIVE DEVICE SETTING

A. After approval of final power system study submittal, set all adjustable device settings listed on the Coordination Study Report. Notify the Engineer in writing when all settings have been completed.

3.5 ARC FLASH STUDY REPORT

A. Prepare a written report indicating the following results of arc flash study for each panelboard, switchboard, switchgear, motor control center, transformer, transfer switch, and disconnect:
   1. Bus voltage (kV)
   2. Bus bolted fault (kA)
   3. Protective device bolted fault (kA)
   4. Protective device arcing fault (kA)
   5. Trip delay time (sec)
   6. Breaker opening time (sec)
   7. Arc gap (mm)
   8. Arc flash boundary (in)
   9. Working distance (in)
   10. Incident energy (cal/cm^2)
   11. Minimum personal protective equipment level as defined in NFPA 70E.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3.6 ARC FLASH WARNING SIGN

A. After final power distribution study report is approved, provide arc flash warning sign on each component included in arc flash study report. The sign shall be in a format as detailed on the drawings or approved equivalent. Sign to comply with requirements outlined in ANSI Z535.4-1998. Signs to be firmly attached to metal covers using two screws or pop rivets.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 500 kVA:
   1. Distribution transformers.
   2. Control and signal transformers.

1.3 SUBMITTALS

A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   1. Wiring Diagrams: Power, signal, and control wiring.

C. Qualification Data: For testing agency.

D. Source quality-control test reports.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

1.5 DELIVERY, STORAGE, AND HANDLING

A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Cover ventilating openings to keep out dust.

C. Handle transformers using only lifting lugs and brackets provided for that purpose. Protect units against entrance of rain, sleet, or snow if handled in inclement weather.

1.6 COORDINATION

A. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eaton Electrical Inc.; Cutler-Hammer Products.
2. General Electric Company.
3. Siemens Energy & Automation, Inc.
4. Square D; Schneider Electric.
5. Or approved equal.

2.2 GENERAL TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service. Ratings, primary voltage, and secondary voltage as indicated on the drawings.

B. Cores: Grain-oriented, non-aging silicon steel.

C. Coils: Continuous windings without splices except for taps.
1. Internal Coil Connections: Brazed or pressure type.
2. Coil Material: Copper.

2.3 DISTRIBUTION TRANSFORMERS

A. Comply with NEMA ST 20, and list and label as complying with UL 1561.

B. Provide transformers that are constructed to withstand seismic forces specified in Division 26.

C. Cores: One leg per phase.

D. Enclosure: Ventilated, drip-proof, NEMA 250, Type 2.
1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

E. Transformer Enclosure Finish: Comply with NEMA 250.
   1. Finish Color: Gray.

F. Taps for Transformers Smaller than 3 kVA: None.

G. Taps for Transformers 7.5 to 24 kVA: Two 5 percent taps below rated voltage.

H. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity.

I. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 150 deg C rise above 40 deg C ambient temperature.

J. Energy Efficiency for Transformers Rated 15 kVA and Larger:
   1. Complying with NEMA TP 1, Class 1 efficiency levels.
   2. Tested according to NEMA TP 2.

K. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for nonsinusoidal load current-handling capability to the degree defined by designated K-factor.
   1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor.
   2. Indicate value of K-factor on transformer nameplate.

L. Wall Brackets: Manufacturer's standard brackets.

M. Low-Sound-Level Requirements: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91.

N. Isolate and coil from enclosure using vibration-absorbing mounts.

O. Case temperature shall not exceed 35 degrees C. rise above ambient at its warmest point.

P. Basic Impulse Level: 10 KV for transformers less than 300 KVA, 30 KV for transformers 300 KVA and larger.

Q. Nameplate: Include transformer connection data.

R. Provide transformer with lug kits which are compatible with the type and ampacity of the windings.

S. Low-Sound-Level Requirements: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91.

2.4 IDENTIFICATION DEVICES

A. Nameplates: Engraved, laminated-plastic or metal nameplate for each distribution transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section "Identification for Electrical Systems."

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2.5 SOURCE QUALITY CONTROL

A. Test and inspect transformers according to IEEE C57.12.91.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.

B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

D. Verify that ground connections are in place and requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.
   1. Brace wall-mounting transformers as specified in Division 26.

B. Construct concrete bases and anchor floor-mounting transformers according to manufacturer's written instructions, seismic codes applicable to Project, and requirements in Division 26.

C. Mounting: Transform``ers 45 KVA and less shall be suitable for wall, floor or trapeze mounting; transformers larger than 45 KVA shall be suitable for floor or trapeze mounting. Actual mounting of each transformer shall be as indicated on the drawings.

D. Do not install any transformer above a ceiling.

3.3 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems." Ground core and coil assembly to enclosure by means of a flexible copper grounding strap.

B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables." Use flexible conduit, two feet minimum, six feet maximum length, for connections of primary and secondary feeders.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 ADJUSTING

A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.

B. Output Settings Report: Prepare a written report recording output voltages and tap settings.

C. Provide touch-up painting for all scratched or marred surfaces to match original finish.

3.5 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
1. Service and distribution switchboards rated 600 V and less.
2. Transient voltage suppression devices.
3. Disconnecting and overcurrent protective devices.
4. Instrumentation.
5. Control power.
6. Accessory components and features.
7. Identification.
8. Mimic bus.

1.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Switchboards shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.4 SUBMITTALS

A. Product Data: For each type of switchboard, overcurrent protective device, transient voltage suppression device, ground-fault protector, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

B. Shop Drawings: For each switchboard and related equipment.
1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types for types other than NEMA 250, Type 1.
3. Detail bus configuration, current, and voltage ratings.
4. Detail short-circuit current rating of switchboards and overcurrent protective devices.
5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
6. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards; quantity and type of curves should comply with requirements in Division 26 Section "Power Distribution Equipment Studies".
7. Include diagram and details of proposed mimic bus.
8. Include schematic and wiring diagrams for power, signal, and control wiring.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

C. Samples: Representative portion of mimic bus with specified material and finish, for color selection.

D. Qualification Data: For qualified installer.

E. Field Quality-Control Reports:
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

F. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
   1. Routine maintenance requirements for switchboards and all installed components.
   2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
   3. Time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

G. Fault-Current and Coordination Studies shall be submitted as a part of the Power Distribution Equipment Submittal and comply with requirements in Division 26 Section "Power Distribution Equipment Studies". Examine overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Selection of overcurrent devices shall be made to provide coordinated system of overcurrent devices as defined in Division 26 Section "Power Distribution Equipment Studies".

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.

B. Testing Agency Qualifications: Member company of NETA or an NRTL.
   1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

C. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

D. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

F. Comply with NEMA PB 2.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

G. Comply with NFPA 70.

H. Comply with UL 891.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.

B. Remove loose packing and flammable materials from inside switchboards and install temporary electric heating (250 W per section) to prevent condensation.

C. Handle and prepare switchboards for installation according to NEMA PB 2.1.

1.7 PROJECT CONDITIONS

A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.

B. Environmental Limitations:
1. Do not deliver or install switchboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above switchboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
   a. Ambient Temperature: Not exceeding 104 deg F (40 deg C).
   b. Altitude: Not exceeding 6600 feet (2000 m).

C. Service Conditions: NEMA PB 2, usual service conditions, as follows:
1. Ambient temperatures within limits specified.
2. Altitude not exceeding 6600 feet (2000 m).

D. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
1. Notify Construction Manager and Owner no fewer than 14 days in advance of proposed interruption of electric service.
2. Indicate method of providing temporary electric service.
3. Do not proceed with interruption of electric service without Construction Manager's and Owner's written permission.
4. Comply with NFPA 70E.

1.8 COORDINATION

A. Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Five years from date of Substantial Completion.

1.10 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Potential Transformer Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
   2. Control-Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
   3. Indicating Lights: Equal to 10 percent of quantity installed for each size and type, but no fewer than one of each size and type.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
   3. Square D; a brand of Schneider Electric.
   4. Or approved equal.

B. Front-Connected, Front-Accessible Switchboards:
   1. Main Devices: Fixed, individually mounted.
   2. Branch Devices: Panel mounted.
   3. Sections front and rear aligned.

C. Seismic Requirements: Fabricate and test switchboards according to IEEE 344 to withstand seismic forces defined in Division 26.

D. Indoor Enclosures: Steel, NEMA 250, Type 1.

E. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

F. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.

G. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.

H. Buses and Connections: Three phase, three wire unless otherwise indicated.
1. Phase-Bus Material: Tin-plated, high-strength, electrical-grade aluminum alloy with tin-plated aluminum circuit-breaker line connections.
2. Ground Bus: 1/4-by-2-inch- (6-by-50-mm-) hard-drawn copper of 98 percent conductivity, equipped with mechanical connectors for feeder and branch-circuit ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.
3. Main Phase Buses and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.

I. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

J. Bus-Bar Insulation: Factory-applied, flame-retardant, tape wrapping of individual bus bars or flame-retardant, spray-applied insulation. Minimum insulation temperature rating of 105 deg C.

2.2 TRANSIENT VOLTAGE SUPPRESSION DEVICES

A. As specified under Division 26.

2.3 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Selection of Overcurrent Devices: Overcurrent device types; from those listed below shall be selected to provide a coordinated system of overcurrent devices as defined in Division 26 Section "Power Distribution Equipment Studies".

B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits.
2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
4. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
   a. Standard frame sizes, trip ratings, and number of poles.
   b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.
   c. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2.4 INSTRUMENTATION

A. Instrument Transformers: IEEE C57.13, NEMA EI 21.1, and the following:
   1. Current Transformers: IEEE C57.13; 5 A, 60 Hz, secondary; bar or window type; single secondary winding and secondary shorting device. Burden and accuracy shall be consistent with connected metering and relay devices.

B. Provide power monitoring devices for switchboards as indicated on the Drawings. Unit to be suitable for three-wire systems, and have the following features:
   1. Switch-selectable digital display with the following features:
      a. Phase Currents, Each Phase: Plus or minus 1 percent.
      b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
      c. Three-Phase Real Power: Plus or minus 2 percent.
      d. Three-Phase Reactive Power: Plus or minus 2 percent.
      e. Power Factor: Plus or minus 2 percent.
      f. Frequency: Plus or minus 0.5 percent.
      g. Accumulated Energy, Megawatt Hours: Plus or minus 2 percent; accumulated values unaffected by power outages up to 72 hours.
      h. Megawatt Demand: Plus or minus 2 percent; demand interval programmable from five to 60 minutes.
   2. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.

2.5 IDENTIFICATION

A. Mimic Bus: Entire single-line switchboard bus work, as depicted on factory record drawing, on a photoengraved nameplate.
   1. Nameplate: At least 0.032-inch- (0.813-mm-) thick anodized aluminum, located at eye level on front cover of the switchboard incoming service section.

B. Coordinate mimic-bus segments with devices in switchboard sections to which they are applied. Produce a concise visual presentation of principal switchboard components and connections.

C. Presentation Media: Painted graphics in color contrasting with background color to represent bus and components, complete with lettered designations.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store switchboards according to NECA 400 and NEMA PB 2.1.

B. Examine switchboards before installation. Reject switchboards that are moisture damaged or physically damaged.

C. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance of the Work.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install switchboards and accessories according to NECA 400 and NEMA PB 2.1.

B. Equipment Mounting: Install switchboards on concrete base, 4-inch (100-mm) nominal thickness. Comply with requirements for concrete base specified in Division 03 Section "Cast-in-Place Concrete."
   1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
   2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   4. Install anchor bolts to elevations required for proper attachment to switchboards.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.

D. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.

E. Install filler plates in unused spaces of panel-mounted sections.

F. Install overcurrent protective devices, transient voltage suppression devices, and instrumentation.
   1. Set field-adjustable switches and circuit-breaker trip ranges.

G. Comply with NECA 1.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Acceptance Testing Preparation:
   1. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

C. Tests and Inspections:
   1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
   3. Perform the following infrared scan tests and inspections and prepare reports:
      a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switchboard. Remove front panels so joints and connections are accessible to portable scanner.
      b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchboard 11 months after date of Substantial Completion.
      c. Instruments and Equipment:
         1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
   4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. Switchboard will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Power Distribution Equipment Studies".

3.6 PROTECTION

A. Temporary Heating: Apply temporary heat, to maintain temperature according to manufacturer's written instructions, until switchboard is ready to be energized and placed into service.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories, and to use and reprogram microprocessor-based trip, monitoring, and communication units.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes the following equipment rated 600V or less.
   1. Distribution panelboards.
   2. Lighting and appliance branch-circuit panelboards.

1.3 DEFINITIONS

A. SVR: Suppressed voltage rating.

B. TVSS: Transient voltage surge suppressor.

1.4 SUBMITTALS

A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.
   1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
   2. Detail enclosure types and details for types other than NEMA 250, Type 1.
   3. Detail bus configuration, current, and voltage ratings.
   4. Short-circuit current rating of panelboards and overcurrent protective devices.
   5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
   6. Include wiring diagrams for power, signal, and control wiring.

C. Field Quality-Control Reports:
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

D. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

E. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NEMA PB 1.

D. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.

B. Handle and prepare panelboards for installation according to NEMA PB 1.

1.7 PROJECT CONDITIONS

A. Environmental Limitations:
1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:
1. Ambient temperatures within limits specified.
2. Altitude not exceeding 6600 feet (2000 m).

C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
1. Notify Owner no fewer than two days in advance of proposed interruption of electric service.
2. Do not proceed with interruption of electric service without Owner's written permission.
3. Comply with NFPA 70E.

1.8 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment,

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Division 26.

B. Enclosures: Surface-mounted cabinets.
   1. Rated for environmental conditions at installed location.
      a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
   2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
   3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
   4. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
   5. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
   6. Finishes:
      a. Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
      b. Back Boxes: Same finish as panels and trim.
   7. Directory Card: Inside panelboard door, mounted in metal frame with transparent protective cover.

C. Incoming Mains Location: Top and bottom.

D. Phase, Neutral, and Ground Buses:
   1. Material: Hard-drawn copper, 98 percent conductivity.
   2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
   3. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.
   4. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

E. Conductor Connectors: Suitable for use with conductor material and sizes.
   1. Material: Tin-plated aluminum.
   2. Main and Neutral Lugs: Mechanical type.
   3. Ground Lugs and Bus-Configured Terminators: Mechanical type.
   4. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
   5. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
   6. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.

F. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

G. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.2 DISTRIBUTION PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
   3. Siemens Energy & Automation, Inc.
   4. Square D; a brand of Schneider Electric.
   5. Or approved equal.

B. Panelboards: NEMA PB 1, power and feeder distribution type.

C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

D. Mains: As indicated on drawings.

E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.

F. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
   3. Siemens Energy & Automation, Inc.
   4. Square D; a brand of Schneider Electric.
   5. Or approved equal.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

C. Mains: As indicated on drawings.

D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

E. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

F. Column-Type Panelboards: Narrow gutter extension, with cover, to overhead junction box equipped with ground and neutral terminal buses.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.
5. Or approved equal.

B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
   a. Instantaneous trip.
   b. Long- and short-time pickup levels.
   c. Long- and short-time time adjustments.
   d. Ground-fault pickup level, time delay, and I^2t response.
3. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
4. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
   a. Standard frame sizes, trip ratings, and number of poles.
   b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
   c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits; Type HACR for heating, air condition and refrigeration equipment.
   d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
   e. Communication Capability: Circuit-breaker-mounted communication module with functions and features compatible with power monitoring and control system.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

f. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
g. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.
h. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
i. Multipole units enclosed in a single housing or factory assembled to operate as a single unit.
j. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in off position.
k. Provide UL-listed lock-on devices for circuit breakers which serve battery-powered egress lighting, night lighting, alarm systems, or any circuit where interruption of power is not desired.

C. Twin breakers in one pole space (tandem breakers) are not acceptable.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.

B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.

C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install panelboards and accessories according to NEMA PB 1.1.

B. Mount top of trim 78 inches (1950 mm) above finished floor unless otherwise indicated.

C. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

D. Panelboards installed on exterior walls shall be mounted in Unistrut, or approved equal, to provide a minimum of one inch air space between panel and wall.

E. Install filler plates in unused spaces.

F. Stub four 1-inch (27-GRC) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

G. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

H. Comply with NECA 1.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

A. Acceptance Testing Preparation:
1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Measure resistance of each bus phase to phase and phase to ground for one minute each. Test voltage shall be 1000 volts. Minimum acceptance insulation resistance shall be 2 mega ohms.
3. Measure resistance between ground bus and panelboard enclosure. Maximum resistance shall be 001 ohms.
4. Test continuity of each circuit.

B. Tests and Inspections:
1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:
    a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
    b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
    c. Instruments and Equipment:
        1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

C. Panelboards will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as indicated.

C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.
   1. Measure as directed during period of normal system loading.
   2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
   3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
   4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.6 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Receptacles, receptacles with integral GFCI, and associated device plates.
   2. Snap switches and wall-box dimmers.
   3. Wall box dimmers.
   4. Occupancy sensors.

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.

B. GFCI: Ground-fault circuit interrupter.

C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

D. RFI: Radio-frequency interference.

E. TVSS: Transient voltage surge suppressor.

F. UTP: Unshielded twisted pair.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1.6 COORDINATION

A. Receptacles for Owner-Furnished Equipment: Match plug configurations.
   1. Cord and Plug Sets: Match equipment requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:
   1. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).
   2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
   3. Leviton Mfg. Company Inc. (Leviton).
   4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).
   5. Crouse-Hinds Electric Company, Distribution Equipment Division.
   6. Killark Electric Manufacturing Company.
   7. Or approved equal.

2.2 STRAIGHT BLADE RECEPTACLES

A. Convenience Receptacles, 125 V, NEMA 5-20R, 20 A: Specification grade. Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.
   1. Terminals: Screw terminals. Devices shall not have clamping terminals.
   2. Line Contacts: Triple-wipe nickel-plated brass "T" contacts.
   3. Ground Contacts: Double-wipe contacts.
   4. Mounting Strap: One-piece, non-riveted, nickel-plated brass grounding system and mounting strap.

B. Isolated-Ground, Duplex Convenience Receptacles, 125 V, 20 A: Specification grade, duplex receptacle. Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.
   1. Description: Straight blade; equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

2.3 GFCI RECEPTACLES

A. General Description: Straight blade, non-feed-through type. Specification grade, NEMA 5-20R duplex receptacle. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped. Design units for installation in a 2-3/4 inch(70mm) deep outlet box without an adapter.

B. GFCI receptacles to provide end of life provision. When a GFCI receptacle is incapable of passing its internal test function it will comply with either 1 or 2 below:
   1. Render itself incapable of delivering power.
   2. Indicate by visual and/or audible means that the device must be replaced.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

C. Reverse Line-Load Miswire: A GFCI receptacle will deny power to the receptacle face if it is miswired.

2.4 PENDANT CORD-CONNECTOR DEVICES

A. Description: Matching, locking-type plug and receptacle body connector; NEMA WD 6 configurations L5-20P and L5-20R, heavy-duty grade.
   1. Body: Nylon with screw-open cable-gripping jaws and provision for attaching external cable grip.
   2. External Cable Grip: Woven wire-mesh type made of high-strength galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

2.5 CORD AND PLUG SETS

A. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.
   1. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and equipment-rating ampacity plus a minimum of 30 percent.
   2. Plug: Nylon body and integral cable-clamping jaws. Match cord and plug with receptacle type for connection.

2.6 SNAP SWITCHES

A. Comply with NEMA WD 1 and UL 20.

B. Switches, 120/277 V, 20 A: Single, two-face, three-way, four-way; comply with DSCC W-C-896F and UL 20 15 amp and/or 20 amp.
   1. Toggle Construction: Thermoplastic.
   2. Mounting Strap: Zinc-plated steel mounting strap.
   3. Single-Pole Switch: Single pole, single-throw for one conductor.
   4. Two-Pole Switch: Double-pole, single-throw for two conductors.
   5. Three-Way Switch: Single-pole, double-throw for three conductors.
   6. Four-Way Switch: Double pole, double-throw for four conductors.

C. Toggle Switches: Specification grade, quiet type.

2.7 WALL-BOX DIMMERS

A. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.

B. Control: Continuously adjustable slider; with single-pole or three-way switching. Comply with UL 1472.

C. Incandescent Lamp Dimmers: 120 V; control shall follow square-law dimming curve. On-off switch positions shall bypass dimmer module.
   1. 600 W minimum; dimmers shall require no derating when ganged with other devices.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

D. Fluorescent Lamp Dimmer Switches: Modular; compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming with low end not greater than 20 percent of full brightness.

2.8 OCCUPANCY SENSORS

2.9 OCCUPANCY SENSORS

A. Wall- and Ceiling-Mounted Switch Sensors:
   1. Description: Dual technology, with both passive-infrared- and ultrasonic-type sensing, 120/277 V, adjustable time delay up to 30 minutes, 180-degree field of view, and a minimum coverage area of 300 square feet (56 square m).

2.10 WALL PLATES

A. Single and combination types to match corresponding wiring devices.
   1. Plate-Securing Screws: Metal with head color to match plate finish.
   2. Material for Finished Spaces: Smooth, high-impact thermoplastic, 0.035-inch- (1-mm-) thick, satin-finished Type 302 or Type 304 non-magnetic stainless steel.
   3. Material for Unfinished Spaces: Galvanized steel.
   4. Material for Damp Locations: Thermoplastic with spring-loaded lift cover, and listed and labeled for use in "wet locations."

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant, polycarbonate with lockable cover. UV stabilized with gasket and hinged device covers listed and labeled "wet location while in use". Hubbell WP826 series or Taymac MM400 or approved equal.

C. Provide panel circuit number engraved in 1/8 inch letters on all emergency powered receptacles. Also provide panel circuit numbers on all normal powered receptacles in general and critical care patient rooms.

D. Color:
   1. Wiring Devices Connected to Normal Power System: Gray in Plant area; White in finished areas, unless otherwise indicated or required by NFPA 70.

E. Provide a blank cover plate in finished areas for all blank telephone and/or data outlet boxes.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.

B. Install wall switches with centerline 46 inches above floor, OFF position down.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

C. Install convenience receptacles vertical, centerline 18 inches above floor. Where receptacles are indicated as above counter, install centerline at 4 inches above counters and backsplash. Install centerline at 46 inches above floor if no counter or backsplash is present. Review approved casework shop drawings prior to any above counter rough-ins.

D. Install specific-use receptacles such as electric water coolers at heights as required by the equipment manufacturer.

E. Install devices and assemblies level, plumb, and square with building lines.

F. Install wall dimmers to achieve indicated rating after derating for ganging according to manufacturer's written instructions.

G. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' written instructions.

H. Where two or more receptacles or switches are shown immediately adjacent, install in multi-gang outlet boxes under a single cover plate. Where voltage between adjacent switches in a common outlet box exceeds 300 volts (277 volt lighting circuits on different phases) provide a permanent barrier between switches in accordance with NEC 2002 Article 380.

I. Install GFI type receptacles for all receptacles indicated as weatherproof. Install receptacle vertical with centerline 24 inches above floor or finished grade, with weatherproof cover hinge up.

J. Install GFI type receptacles where located within six feet of sinks.

K. Remove wall plates and protect devices and assemblies during painting.

L. Coordination with Other Trades:
   1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.
   2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
   3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
   4. Install wiring devices after all wall preparation, including painting, is complete.

M. Conductors:
   1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
   2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
   3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
   4. Existing Conductors:
      a. Cut back and pigtail, or replace all damaged conductors.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

b. Straighten conductors that remain and remove corrosion and foreign matter.
c. Pigtailing existing conductors is permitted provided the outlet box is large enough.

N. Device Installation:
1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches (152 mm) in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.

O. Receptacle Orientation:
1. Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the left.

P. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

Q. Dimmers:
1. Install dimmers within terms of their listing.
2. Verify that dimmers used for fan speed control are listed for that application.
3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.

R. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

S. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 IDENTIFICATION

A. Comply with Division 26 Section "Identification for Electrical Systems."
1. Receptacles: Identify panelboard and circuit number from which served. Use hot, stamped or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.
   1. In healthcare facilities, prepare reports that comply with recommendations in NFPA 99.
   2. Test Instruments: Use instruments that comply with UL 1436.
   3. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.

B. Tests for Convenience Receptacles:
   1. Line Voltage: Acceptable range is 105 to 132 V.
   2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is not acceptable.
   3. Ground Impedance: Values of up to 2 ohms are acceptable.
   4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
   5. Using the test plug, verify that the device and its outlet box are securely mounted.
   6. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

C. Remove malfunctioning units, replace with new units, and retest as specified above.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
1. Cartridge fuses rated 600-V ac and less for use in enclosed switches and controllers.
2. Spare-fuse cabinets.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material, dimensions, descriptions of individual components, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:
1. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
2. Fuse sizes for elevator feeders and elevator disconnect switches.

B. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
1. Ambient temperature adjustment information.
2. Current-limitation curves for fuses with current-limiting characteristics.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NEMA FU 1 for cartridge fuses.

D. Comply with NFPA 70.

E. Comply with UL 248-11 for plug fuses.

1.5 PROJECT CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F (5 deg C) or more than 100 deg F (38 deg C), apply manufacturer's ambient temperature adjustment factors to fuse ratings.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1.6 COORDINATION

A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

1.7 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than 6 of each size and type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cooper Bussmann, Inc.
   2. Edison Fuse, Inc.
   3. Ferraz Shawmut, Inc.
   4. Littelfuse, Inc.
   5. General Electric Company.
   6. Or approved equal.

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

2.3 SPARE-FUSE CABINET

A. Characteristics: Wall-mounted steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.
   1. Size: Adequate for storage of spare fuses specified with 15 percent spare capacity minimum.
   2. Finish: Gray, baked enamel.
   3. Identification: "SPARE FUSES" in 1-1/2-inch- (38-mm-) high letters on exterior of door.
   4. Fuse Pullers: For each size of fuse, where applicable and available, from fuse manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.

C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FUSE APPLICATIONS

A. Cartridge Fuses:
   1. Motor Branch Circuits: Class RK1, time delay.
   2. Other Branch Circuits: Class RK1, time delay.

3.3 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

B. Install spare fuse cabinet(s).

3.4 IDENTIFICATION

A. Install labels complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Fusible switches.
   2. Nonfusible switches.
   3. Enclosures.

1.3 DEFINITIONS

A. NC: Normally closed.

B. NO: Normally open.

C. SPDT: Single pole, double throw.

1.4 SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
   1. Enclosure types and details for types other than NEMA 250, Type 1.
   2. Current and voltage ratings.
   3. Short-circuit current ratings (interrupting and withstand, as appropriate).
   4. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.

B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.
   1. Wiring Diagrams: For power, signal, and control wiring.

C. Field quality-control reports.
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

D. Manufacturer's field service report.

E. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
   1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1.5 QUALITY ASSURANCE

A. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NFPA 70.

D. Comply with NEMA AB 1.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
   1. Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 104 deg F (40 deg C).
   2. Altitude: Not exceeding 6600 feet (2010 m).

B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
   1. Notify Owner no fewer than seven days in advance of proposed interruption of electric service.
   2. Indicate method of providing temporary electric service.
   3. Do not proceed with interruption of electric service without Owner's written permission.
   4. Comply with NFPA 70E.

1.7 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
   3. Square D; a brand of Schneider Electric.
   4. Or approved equal.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:
   1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
   2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
   3. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.2 NONFUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
   3. Square D; a brand of Schneider Electric.
   4. Or approved equal.

B. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:
   1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
   2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
   3. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.3 ENCLOSURES

A. Enclosed Switches: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
   1. Indoor, Dry, Clean Finished Locations: NEMA 250, Type 1.
   2. Outdoor Locations: NEMA 250, Type 4X.
   3. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4X.
   4. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3.2 INSTALLATION

A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

C. Install fuses in fusible devices.

D. Comply with NECA 1.

E. Enclosed switches shall be installed with center line 66 inches above finish floor or grade, unless otherwise noted. Provide working clearance in front of enclosed switches and circuit breakers as required by the applicable National Electrical Code, Article 110.

F. Install all enclosed switches surface mounted unless otherwise noted.

3.3 IDENTIFICATION

A. Comply with requirements in Division 26 Section "Identification for Electrical Systems."
   1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
   2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 FIELD QUALITY CONTROL

A. Acceptance Testing Preparation:
   1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

B. Tests and Inspections:
   1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

C. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. General-purpose contactors.

B. Lighting contactors.

C. Enclosures.

1.3 REFERENCES

A. ANSI/NEMA ICS 6 - Enclosures for Industrial Controls and Systems.

B. NEMA ICS 2 - Industrial Control Devices, Controllers, and Assemblies.

1.4 SUBMITTALS

A. Product Data: For each type of contactor indicated.

PART 2 - PRODUCTS

2.1 AVAILABLE MANUFACTURERS

A. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. General Electric – Distribution and Control.
   2. Square D Company; Schneider Electric.
   3. Eaton Corp., Cutler-Hammer products.
   4. Or approved equal.

2.2 LIGHTING CONTACTORS

A. Contactors: NEMA ICS 2; mechanically held wire control.

B. Coil Operating Voltage: 120 volts, 60 Hertz.

C. Contacts: 30 amperes, 12 poles, 480 volts, 60 Hertz. Provide silver-cadmium oxide double break type.

D. Enclosure: ANSI/NEMA ICS 6; Type 1 indoors and Type 3R outdoors.

E. Provide solderless pressure wire terminals.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

F. Provide field convertible N.O. and N.C. contacts.

G. Contactor shall be surface mounted.

2.3 GENERAL PURPOSE CONTACTORS

A. Contactors: NEMA ICS 2; electrically held, 2-wire control.

B. Coil Operating Voltage: 120 volts, 60 Hertz.

C. Size: NEMA ICS 2; as indicated on Drawings, size 0 minimum.

D. Contacts: 30 ampere, 12 pole, 480 volts, 60 Hertz. Provide silver cadmium-oxide double break type.

E. Enclosure: ANSI/NEMA ICS 6; surface-mounted:
1. Indoor Dry, Clean Finished Areas: NEMA 250, Type 1.
2. Outdoor Locations: NEMA 250, Type 4X.
3. Other Wet or Damp Indoor Locations: NEMA 250, Type 4X.
4. Hazardous Areas Indicated on the Drawings: NEMA 250, Type 7.

F. Provide solderless pressure wire terminals.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Mount centerline at 66 inches above the finished floor. Meet all applicable clearance requirements.

C. Label enclosure as specified in Division 26 Section "Identification for Electrical Systems".

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes solid-state, PWM, VFCs for speed control of three-phase, squirrel-cage induction motors.

B. Related Sections include the following:
   1. Division 26 Section "Transient-Voltage Suppression" for low-voltage power, control, and communication surge suppressors.

1.3 DEFINITIONS

A. BMS: Building management system.

B. IGBT: Integrated gate bipolar transistor.

C. LAN: Local area network.

D. PID: Control action, proportional plus integral plus derivative.

E. PWM: Pulse-width modulated.

F. VFC: Variable frequency controller.

1.4 SUBMITTALS

A. Product Data: For each type of VFC. Include dimensions, mounting arrangements, location for conduit entries, shipping and operating weights, and manufacturer's technical data on features, performance, electrical ratings, characteristics, and finishes.

B. Shop Drawings: For each VFC.
   1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:
      a. Each installed unit's type and details.
      b. Nameplate legends.
      c. Short-circuit current rating of integrated unit.
      d. Listed and labeled for series rating of overcurrent protective devices in combination controllers by an NRTL acceptable to authorities having jurisdiction.
   2. Wiring Diagrams: Power, signal, and control wiring for VFCs. Provide schematic wiring diagram for each type of VFC.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

C. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around VFCs where pipe and ducts are prohibited. Show VFC layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

D. Harmonic Analysis:
   1. Perform harmonic analysis with the system on utility source and VFC systems operating at maximum load from a single supply transformer.
   2. Submit analysis including all individual affected voltage and current harmonics up to the 50^{th}.
   3. Indicate projected percentage voltage and current distortion at the utility connection.

E. Torsional Analysis:
   1. Submit a mechanical vibration and resonance analysis of the VFC, motor, coupling, and pump to be furnished.

F. Qualification Data: For manufacturer.

G. Field quality-control test reports.

H. Operation and Maintenance Data: For VFCs, all installed devices, and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
   1. Routine maintenance requirements for VFCs and all installed components.
   2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 100 miles (160 km) of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.

B. Source Limitations: Obtain VFCs of a single type through one source from a single manufacturer.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with NFPA 70.

E. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFCs, minimum clearances between VFCs, and adjacent surfaces and other items. Comply with indicated maximum dimensions and clearances.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver VFCs in shipping splits of lengths that can be moved past obstructions in delivery path as indicated.

B. Store VFCs indoors in clean, dry space with uniform temperature to prevent condensation. Protect VFCs from exposure to dirt, fumes, water, corrosive substances, and physical damage.

C. If stored in areas subject to weather, cover VFCs to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; install electric heating of sufficient wattage to prevent condensation.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation, capable of driving full load without derating, under the following conditions, unless otherwise indicated:
   1. Ambient Temperature: 0 to 40 deg C.
   2. Humidity: Less than 90 percent (noncondensing).
   3. Altitude: Not exceeding 3300 feet (1005 m).

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFCs, including clearances between VFCs, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

1.8 COORDINATION

A. Coordinate layout and installation of VFCs with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."

C. Coordinate features of VFCs, installed units, and accessory devices with pilot devices and control circuits to which they connect.

D. Coordinate features, accessories, and functions of each VFC and each installed unit with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

1.9 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Spare Fuses: Furnish one spare for every five installed, but no fewer than one set of three of each type and rating.
   2. Indicating Lights: Two of each type installed.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Eaton Corporation; Cutler-Hammer Products.
   2. General Electric Company; GE Industrial Systems.
   3. Rockwell Automation; Allen-Bradley Co.; Industrial Control Group.
   4. Square D; Schneider Electric.
   5. Or approved equal.

2.2 VARIABLE FREQUENCY CONTROLLERS

A. Description: NEMA ICS 2, IGBT, PWM, VFC; listed and labeled as a complete unit and arranged to provide variable speed of an NEMA MG 1, Design B, 3-phase induction motor by adjusting output voltage and frequency.
   1. Provide unit suitable for operation of standard and premium-efficiency motor as defined by NEMA MG 1.
   2. 18-pulse output for motors rated 50 hp and greater.
   3. 6-pulse output with 5 percent line reactor for motors rated less than 50 hp.

B. Design and Rating: Match load type such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.

C. Output Rating: 3-phase; 6 to 66 Hz, with torque constant as speed changes.

D. Unit Operating Requirements:
   1. Input ac voltage tolerance of 380 to 500 V, plus or minus 10 percent.
   2. Input frequency tolerance of 50/60 Hz, plus or minus 6 percent.
   3. Minimum Efficiency: 96 percent at 60 Hz, full load.
   4. Minimum Displacement Primary-Side Power Factor: 96 percent.
   5. Overload Capability: 1.1 times the base load current for 60 seconds; 2.0 times the base load current for 3 seconds.
   6. Starting Torque: 100 percent of rated torque or as indicated.
   7. Speed Regulation: Plus or minus 1 percent.
   8. Ambient Temperature: 0 to 40 degrees C.

E. Isolated control interface to allow controller to follow control signal over an 11:1 speed range.
   1. Electrical Signal: 4 to 20 mA at 24 V.

F. Internal Adjustability Capabilities:
   1. Minimum Speed: 5 to 25 percent of maximum rpm.
   2. Maximum Speed: 80 to 100 percent of maximum rpm.
   3. Acceleration: 2 to a minimum of 22 seconds.
   4. Deceleration: 2 to a minimum of 22 seconds.
   5. Current Limit: 50 to a minimum of 110 percent of maximum rating.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

G. Self-Protection and Reliability Features:
   1. Input transient protection by means of surge suppressors.
   2. Under- and overvoltage trips; inverter overtemperature, overload, and overcurrent trips.
   3. Motor Overload Relay: Adjustable and capable of NEMA ICS 2, Class 20 performance.
   4. Notch filter to prevent operation of the controller-motor-load combination at a natural frequency of the combination.
   5. Instantaneous line-to-line and line-to-ground overcurrent trips.
   6. Loss-of-phase protection.
   7. Reverse-phase protection.
   8. Short-circuit protection.
   9. Motor overtemperature fault.

H. Harmonic Requirements:
   1. As per Table 10.3 of IEEE 519-1992, maximum allowable total harmonic current demand distortion limits for each VFC operating at full load and speed shall not exceed 5 percent as calculated and measured at the point of common coupling (lsc/ll > 20).
   2. The point of common coupling for all harmonic calculations and field measurements for both voltage and current distortion shall be defined as the VFC input terminals.
   3. A preliminary harmonic analysis must be submitted by VFC manufacturer at time of bid, which includes all voltage and current harmonics up to the 99^{th}. Failure to supply this harmonic analysis with the bid will result in bid disqualification.

I. Harmonic compliance shall be verified with onsite field measurements of both the voltage and current harmonic distortion at the drive input terminals with and without the VFCs operating. A recording type Fluke 41 or equivalent harmonic analyzer displaying individual and total harmonic currents and voltages must be utilized.

J. VFC system shall maintain a .95 minimum true power factor throughout the entire speed range.

K. Automatic Reset/Restart: Attempts three restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction. Bidirectional autospeed search shall be capable of starting into rotating loads spinning in either direction and returning motor to set speed in proper direction, without damage to controller, motor, or load.

L. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped.

M. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

N. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

O. Status Lights: Door-mounted LED indicators shall indicate the following conditions:
   1. Power on.
   2. Run.
   3. Overvoltage.
   4. Line fault.
   5. Overcurrent.
   6. External fault.

P. Panel-Mounted Operator Station: Start-stop and auto-manual selector switches with manual speed control potentiometer and elapsed time meter.

Q. Indicating Devices: Meters or digital readout devices and selector switch, mounted flush in controller door and connected to indicate the following controller parameters:
   1. Output frequency (Hz).
   2. Motor speed (rpm).
   3. Motor status (running, stop, fault).
   4. Motor current (amperes).
   5. Motor torque (percent).
   6. Fault or alarming status (code).
   7. PID feedback signal (percent).
   8. DC-link voltage (VDC).
   9. Set-point frequency (Hz).
   10. Motor output voltage (V).

R. Control Signal Interface:
   1. Electric Input Signal Interface: A minimum of 2 analog inputs (0 to 10 V or 0/4-20 mA) and 6 programmable digital inputs.
   2. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the BMS or other control systems:
      a. 0 to 10-V dc.
      b. 0-20 or 4-20 mA.
      c. Potentiometer using up/down digital inputs.
      d. Fixed frequencies using digital inputs.
      e. RS485.
      f. Keypad display for local hand operation.
   3. Output Signal Interface:
      a. A minimum of 1 analog output signal (0/4-20 mA), which can be programmed to any of the following:
         1) Output frequency (Hz).
         2) Output current (load).
         3) DC-link voltage (VDC).
         4) Motor torque (percent).
         5) Motor speed (rpm).
         6) Set-point frequency (Hz).
   4. Remote Indication Interface: A minimum of 2 dry circuit relay outputs (120-V ac, 1 A) for remote indication of the following:
      a. Motor running.
      b. Set-point speed reached.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

c. Fault and warning indication (overtemperature or overcurrent).
d. PID high- or low-speed limits reached.

S. Communications: Provide an RS485 interface allowing VFC to be used with an external system within a multidrop LAN configuration. Interface shall allow all parameter settings of VFC to be programmed via BMS control. Provide capability for VFC to retain these settings within the nonvolatile memory.

T. Integral Disconnecting Means: NEMA AB 1, instantaneous-trip circuit breaker, rated for available short circuit current.

U. Remote Indicating Circuit Terminals: Mode selection, controller status, and controller fault.

2.3 ENCLOSURES

A. As specified in equipment Specification with a minimum of NEMA 250, Type 1.

2.4 ACCESSORIES

A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.

B. Provide a green pilot light for running and a red pilot light for stopping for each controller. Provide a hand-off-auto selector switch for each controller UON.

C. Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.

D. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.

E. Control Relays: Auxiliary and adjustable time-delay relays.

F. Standard Displays:
1. Output frequency (Hz).
2. Set-point frequency (Hz).
3. Motor current (amperes).
4. DC-link voltage (VDC).
5. Motor torque (percent).
6. Motor speed (rpm).
7. Motor output voltage (V).

G. Historical Logging Information and Displays:
1. Real-time clock with current time and date.
2. Running log of total power versus time.
3. Total run time.
4. Fault log, maintaining last four faults with time and date stamp for each.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

H. Current-Sensing, Phase-Failure Relays for Bypass Controller: Solid-state sensing circuit with isolated output contacts for hard-wired connection; arranged to operate on phase failure, phase reversal, current unbalance of from 30 to 40 percent, or loss of supply voltage; with adjustable response delay.

2.5 FACTORY FINISHES

A. Finish: Manufacturer's standard gray paint applied to factory-assembled and -tested VFCs before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, surfaces, and substrates to receive VFCs for compliance with requirements, installation tolerances.

B. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFC installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Select features of each VFC to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; and duty cycle of motor, controller, and load.

B. Select horsepower rating of controllers to suit motor controlled.

3.3 INSTALLATION

A. Anchor each VFC assembly to steel-channel sills arranged and sized according to manufacturer's written instructions. Attach by bolting. Level and grout sills flush with mounting surface.

B. Install VFCs on concrete bases.

C. Comply with mounting and anchoring requirements specified in Division 26.

3.4 CONCRETE BASES

A. Coordinate size and location of concrete bases. Verify structural requirements with structural engineer.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Concrete base is specified in Division 26 Section "Common Work Results for Electrical," and concrete materials and installation requirements are specified in Division 03.

3.5 IDENTIFICATION

A. Identify VFCs, components, and control wiring according to Division 26 Section "Identification for Electrical Systems."

B. Operating Instructions: Frame printed operating instructions for VFCs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of VFC units.

3.6 CONTROL WIRING INSTALLATION

A. Install wiring between VFCs and remote devices according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

B. Bundle, train, and support wiring in enclosures.

C. Connect hand-off-automatic switch and other automatic-control devices where applicable.
   1. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.
   2. Connect selector switches with control circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.7 CONNECTIONS

A. Conduit installation requirements are specified in other Division 26 Sections. Drawings indicate general arrangement of conduit, fittings, and specialties.

B. Ground equipment according to Division 26 "Grounding and Bonding for Electrical Systems."

3.8 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:
   1. Test insulation resistance for each enclosed controller element, bus, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following:
   1. Inspect controllers, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
   2. Report results in writing.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

C. Perform the following field tests and inspections and prepare test reports:
   1. Perform each electrical test and visual and mechanical inspection, except optional tests, stated in NETA ATS. Certify compliance with test parameters.
   2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.9 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip ranges.

3.10 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain variable frequency controllers. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes TVSSs for low-voltage power, control, and communication equipment.

B. Related Sections include the following:
   1. Division 26 Section "Panelboards" for factory-installed TVSSs.

1.3 DEFINITIONS

A. ATS: Acceptance Testing Specifications.

B. SVR: Suppressed voltage rating.

C. TVSS: Transient voltage surge suppressor.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating weights, operating characteristics, furnished specialties, and accessories.

B. Product Certificates: For transient voltage suppression devices, signed by product manufacturer certifying compliance with the following standards:
   1. UL 1283.
   2. UL 1449, Second Edition.

C. Field quality-control test reports, including the following:
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Failed test results and corrective action taken to achieve requirements.

D. Operation and Maintenance Data: For transient voltage suppression devices to include in emergency, operation, and maintenance manuals.

E. Warranties: Special warranties specified in this Section.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain suppression devices and accessories through one source from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

C. Comply with IEEE C62.41, "IEEE Guide for Surge Voltages in Low Voltage AC Power Circuits," and test devices according to IEEE C62.45, "IEEE Guide on Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits."

D. Comply with NEMA LS 1, "Low Voltage Surge Protection Devices."

E. Comply with UL 1283, "Electromagnetic Interference Filters," and UL 1449, second edition, "Transient Voltage Surge Suppressors."

F. Label components in compliance with NFPA 70, Article 285 with withstand ratings.

1.6 PROJECT CONDITIONS

A. Service Conditions: Rate surge protection devices for continuous operation under the following conditions, unless otherwise indicated:
1. Maximum Continuous Operating Voltage: Not less than 115 percent of nominal system operating voltage.
2. Operating Temperature: 30 to 120 deg F (0 to 50 deg C).
3. Humidity: 0 to 85 percent, noncondensing.
4. Altitude: Less than 20,000 feet (6090 m) above sea level.

1.7 COORDINATION

A. Coordinate location of field-mounted surge suppressors to allow adequate clearances for maintenance.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of surge suppressors that fail in materials or workmanship within five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Advanced Protection Technologies, Inc.
2. Current Technology, Inc.
3. Cutler-Hammer, Inc.; Eaton Corporation.
4. General Electric Company.
5. Square D; Schneider Electric.
6. Or approved equal.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2.2 MOTOR CONTROL CENTERS

A. Surge Protection Device Description: Modular design with field-replaceable modules, sine-wave-tracking type with the following features and accessories:
   1. Fuses, rated at 200-kA interrupting capacity.
   2. Fabrication using bolted compression lugs for internal wiring.
   3. Integral disconnect switch.
   4. Redundant suppression circuits.
   5. Redundant replaceable modules.
   6. Arrangement with wire connections to phase buses, and ground bus.
   7. LED indicator lights for power and protection status.
   8. Audible alarm, with silencing switch, to indicate when protection has failed.
   9. One set of dry contacts rated at 5 A and 250-V ac, for remote monitoring of protection status.
   10. Surge-event operations counter.

B. Peak Single-Impulse Surge Current Rating: 160 kA per phase.

C. Connection Means: Permanently wired.

D. Protection modes and UL 1449 SVR for voltages of 480, 3-phase, 3-wire, delta circuits shall be as follows:
   1. Line to Line: 2000 V for 480 V.
   2. Line to Ground: 2000 V for 480 V.

2.3 PANELBOARD SUPPRESSORS

A. Surge Protection Device Description: Modular design with field-replaceable modules, sign-wave-tracking type with the following features and accessories:
   1. Fabrication using bolted compression lugs for internal wiring.
   2. Integral disconnect switch.
   3. Redundant suppression circuits.
   4. Redundant replaceable modules.
   5. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
   6. LED indicator lights for power and protection status.
   7. Audible alarm, with silencing switch, to indicate when protection has failed.
   8. One set of dry contacts rated at 5 A and 250-V, ac, for remote monitoring of protection status.
   9. Surge-event operations c`ounter.

B. Peak Single-Impulse Surge Current Rating: 80 kA per phase.

C. Protection modes and UL 1449 SVR for grounded wye circuits with voltages of 208Y/120, 3-phase, 4-wire circuits shall be as follows:
   1. Line to Neutral: 400 V for 208Y/120.
   2. Line to Ground: 400 V for 208Y/120.
   3. Neutral to Ground: 400 V for 208Y/120.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 3 - EXECUTION

3.1 INSTALLATION OF SURGE PROTECTION DEVICES

A. Install devices for panelboards and motor control centers with conductors or buses between suppressor and points of attachment as short and straight as possible. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.
   1. Provide multipole circuit breaker as a dedicated disconnect for suppressor, unless otherwise indicated.

3.2 PLACING SYSTEM INTO SERVICE

A. Do not energize or connect panelboards or motor control centers to their sources until surge protection devices are installed and connected.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust equipment installation, including connections. Report results in writing.
   1. Verify that electrical wiring installation complies with manufacturer's written installation requirements.

B. Testing: Perform the following field tests and inspections and prepare test reports:
   1. After installing surge protection devices, but before electrical circuitry has been energized, test for compliance with requirements.
   2. Complete startup checks according to manufacturer's written instructions.
   3. Perform each visual and mechanical inspection and electrical test stated in NETA ATS, "Surge Arresters, Low-Voltage Surge Protection Devices" Section. Certify compliance with test parameters.

C. Remove and replace malfunctioning units and retest as specified above.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transient voltage suppression devices. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Interior lighting fixtures, lamps, and ballasts.
   2. Emergency lighting units.
   3. Exit signs.
   4. Lighting fixture supports.

B. Related Sections include the following:
   1. Division 26 Section "Wiring Devices" for manual wall-box dimmers, ceiling mounted and wall mounted occupancy sensors, and manual light switches.
   2. Division 26 Section "Contactors" for multipole lighting relays and contactors.

1.3 DEFINITIONS

A. BF: Ballast factor.

B. CRI: Color-rendering index.

C. CU: Coefficient of utilization.

D. HID: High-intensity discharge.

E. LER: Luminaire efficacy rating.

F. Luminaire: Complete lighting fixture, including ballast housing if provided.

G. RCR: Room cavity ratio.

1.4 SUBMITTALS

A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:
   1. Physical description of lighting fixture including dimensions.
   2. Emergency lighting units including battery and charger.
   3. Ballast: Provide ballast information for fluorescent and HID fixtures indicating total fixture wattage consumption value.
   4. Energy-efficiency data.
   5. Life, output, and energy-efficiency data for lamps.
   6. Photometric data, in IESNA format, based on laboratory tests of each lighting fixture type, outfitted with lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

a. Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program (NVLAP) for Energy Efficient Lighting Products.

7. Information indicating maximum wattage consumption must be submitted for all fixtures to demonstrate compliance with maximum total wattage allowance shown in light fixture schedule on the Drawings.
8. Provide label on incandescent fixtures with maximum lamp wattages not to exceed those indicated on the light fixture schedule on the Drawings.

B. Shop Drawings: Indicate dimensions, weights, methods of field assembly, components, features, and accessories.
   1. Wiring Diagrams: Power wiring.

C. Qualification Data: For agencies providing photometric data for lighting fixtures.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.

F. Warranties: Special warranties specified in this Section.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

C. FMG Compliance: Lighting fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FMG.

1.6 COORDINATION

A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, piping, ductwork, and partition assemblies.

1.7 WARRANTY

A. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.
   1. Warranty Period for Emergency Lighting Unit Batteries: 10 years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining nine years.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2. Warranty Period for Emergency Fluorescent Ballast and Self-Powered Exit Sign Batteries: Seven years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining six years.

B. Special Warranty for Ballasts: Manufacturer's standard form in which ballast manufacturer agrees to repair or replace ballasts that fail in materials or workmanship within specified warranty period.
   1. Warranty Period for Electronic Ballasts: Five years from date of Substantial Completion.

C. Special Warranty for T8 Fluorescent Lamps: Manufacturer's standard form, made out to Owner and signed by lamp manufacturer agreeing to replace lamps that fail in materials or workmanship, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.
   1. Warranty Period: Two year(s) from date of Substantial Completion.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Lamps: Five of each type and rating installed. Furnish at least one of each type.
   2. Plastic Diffusers and Lenses: Three of each type and rating installed. Furnish at least one of each type.
   3. Battery and Charger Data: One for each type of emergency lighting unit.
   4. Ballasts: Three of each type and rating installed. Furnish at least one of each type.
   5. Globes and Guards: One of each type and rating installed. Furnish at least one of each type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In Interior Lighting Fixture Schedule where titles below are column or row headings that introduce lists, the following requirements apply to product selection:
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
   2. Basis-of-Design Product: The design for each lighting fixture is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product by another manufacturer.

2.2 LIGHTING FIXTURES AND COMPONENTS, GENERAL REQUIREMENTS

A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.

B. Incandescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5A.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

C. Fluorescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable. Provide trim, type, and accessories required for installations in ceiling system where installed.

D. HID Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5B.

E. Metal Parts: Free of burrs and sharp corners and edges.

F. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.

G. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

H. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:
1. White Surfaces: 85 percent.
2. Specular Surfaces: 83 percent.
3. Diffusing Specular Surfaces: 75 percent.
4. Laminated Silver Metallized Film: 90 percent.
5. Contractor shall notify the Design Professional of Record of any specified fixture which does not meet these minimum requirements.

I. Plastic Diffusers, Covers, and Globes:
1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
   a. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless different thickness is indicated.
   b. UV stabilized.
2. Glass: Annealed crystal glass, unless otherwise indicated.

2.3 BALLASTS FOR LINEAR FLUORESCENT LAMPS

A. Electronic Ballasts: Comply with ANSI C82.11; instant-start type, unless otherwise indicated, and designed for type and quantity of lamps served. Ballasts shall be designed for full light output unless dimmer or bi-level control is indicated.
1. Sound Rating: A.
2. Total Harmonic Distortion Rating: Less than 10 percent.
3. Transient Voltage Protection: IEEE C62.41, Category A or better.
4. Operating Frequency: 42 kHz or higher.
5. Lamp Current Crest Factor: 1.7 or less.
6. Power Factor: 0.95 or higher.

B. Ballasts for Low-Temperature Environments:
1. Temperatures 0 Deg F (Minus 17 Deg C) and Higher: Electronic type rated for 0 deg F (minus 17 deg C) starting and operating temperature with indicated lamp types.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

C. Ballasts for Bi-Level Controlled Lighting Fixtures: Electronic type.
   1. Operating Modes: Ballast circuit and leads provide for remote control of the light output of the associated lamp between high- and low-level and off.
      a. High-Level Operation: 100 percent of rated lamp lumens.
      b. Low-Level Operation: 50 percent of rated lamp lumens.
   2. Ballast shall provide equal current to each lamp in each operating mode.
   3. Compatibility: Certified by manufacturer for use with specific bi-level control system and lamp type indicated.

2.4 BALLASTS FOR HID LAMPS

A. Electromagnetic Ballast for Metal-Halide Lamps: Comply with ANSI C82.4 and UL 1029. Include the following features, unless otherwise indicated:
   1. Ballast Circuit: Constant-wattage autotransformer or regulating high-power-factor type.
   2. Minimum Starting Temperature: Minus 22 deg F (Minus 30 deg C) for single-lamp ballasts.
   3. Normal Ambient Operating Temperature: 104 deg F (40 deg C).
   4. Open-circuit operation that will not reduce average life.
   5. Low-Noise Ballasts: Manufacturers' standard epoxy-encapsulated models designed to minimize audible fixture noise.

2.5 EXIT SIGNS

A. Description: Comply with UL 924 and NFPA 101; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction. Provide directional chevrons as indicated the Drawings and use universal mounting type.

B. Internally Lighted Signs:
   1. Lamps for AC Operation: LEDs, 70,000 hours minimum rated lamp life.
   2. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.
      a. Battery: Sealed, maintenance-free, nickel-cadmium type.
      b. Charger: Fully automatic, solid-state type with sealed transfer relay.
      c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
      d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
      e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

2.6 EMERGENCY LIGHTING UNITS

A. Description: Self-contained units complying with UL 924.
   1. Battery: Sealed, maintenance-free, lead-acid type.
   2. Charger: Fully automatic, solid-state type with sealed transfer relay.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3. Operation: Relay automatically turns lamp on when power supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

2.7 FLUORESCENT LAMPS

A. Low-Mercury Lamps: Comply with EPA's toxicity characteristic leaching procedure test; shall yield less than 0.2 mg of mercury per liter when tested according to NEMA LL 1.

B. T8 rapid-start low-mercury lamps, rated 32 W maximum, nominal length of 48 inches (1220 mm), 2800 initial lumens (minimum), CRI 82 (minimum), color temperature 3500 K, and average rated life 20,000 hours, unless otherwise indicated.

2.8 HID LAMPS

A. Metal-Halide Lamps: ANSI C78.1372, with a minimum CRI 65, and color temperature 4000 K.

2.9 LIGHTING FIXTURE SUPPORT COMPONENTS

A. Comply with Division 26 for channel- and angle-iron supports and nonmetallic channel and angle supports.

B. Rod Hangers: 3/16-inch (5-mm) minimum diameter, cadmium-plated, threaded steel rod as indicated on the Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Lighting fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.

B. Support for Lighting Fixtures in or on Grid-Type Suspended Ceilings: Use grid as a support element.
1. Install a minimum of four ceiling support system rods or wires for each fixture. Locate not more than 6 inches (150 mm) from lighting fixture corners.
2. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch (20-mm) metal channels spanning and secured to ceiling tees.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

4. Install at least one independent support rod or wire from structure to a tab on lighting fixture. Wire or rod shall have breaking strength of the weight of fixture at a safety factor of 3.
5. Install to permit removal from below.

C. Suspended Lighting Fixture Support:
1. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.

D. Adjust aimable lighting fixtures to provide required light intensities.

3.2 CLEANING

A. Align luminaries and clean lenses and diffusers at completion of work. Clean paint splatters, dirt, and debris from installed luminaries.

3.3 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.

B. Inspect each installed fixture for damage. Replace damaged fixtures and components.

C. Verify normal operation of each fixture after installation.

D. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

E. Test each fixture for a period of 72 hours total burning time. Replace all defective ballasts or erratic lamps encountered and retest for 24 hours.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Exterior luminaires with lamps and ballasts.
   2. Poles and accessories.

B. Related Sections include the following:
   1. Division 26 Section "Building Lighting" for exterior luminaires normally mounted on exterior surfaces of buildings and automatic control of lighting, including time switches, indoor and outdoor photometric relays/switches, and outdoor motion sensors.
   2. Division 26 Section "Contactors" for multipole lighting relays and contactors.

1.3 DEFINITIONS

A. CRI: Color-rendering index.

B. HID: High-intensity discharge.

C. Luminaire: Complete lighting fixture, including ballast housing if provided.

D. Pole: Luminaire support structure, including tower used for large area illumination.

E. Standard: Same definition as "Pole" above.

1.4 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION

A. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied as stated in AASHTO LTS-4.

B. Ice Load: Load of 3 lbf/sq. ft. (143.6 Pa), applied as stated in AASHTO LTS-4.

C. Wind Load: Pressure of wind on pole and luminaire, calculated and applied as stated in AASHTO LTS-4.
   1. Wind speed for calculating wind load for poles 50 feet (15 m) or less in height is 110 mph (177 km/h).

1.5 SUBMITTALS

A. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:
   1. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2. Details of attaching luminaires and accessories.
3. Details of installation and construction.
4. Luminaire materials.
5. Photometric data based on laboratory tests of each luminaire type, complete with indicated lamps, ballasts, and accessories.
    a. Photometric data shall be certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
6. Photoelectric relays.
7. Ballasts: Provide ballast information for HID fixtures indicating total fixture wattage consumption value.
8. Lamps, including life, output, and energy-efficiency data.
9. Materials, dimensions, and finishes of poles.
10. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.
11. Anchor bolts for poles.
12. Information indicating maximum total wattage consumption must be submitted for all fixtures to demonstrate compliance with maximum wattage allowance shown in Light Fixture Schedule on the Drawings.
13. For any proposed substitutions of site lighting fixtures, provide Site Plan with point-by-point photometric calculations on a 5' x 5' grid for evaluation.

B. Shop Drawings:
    1. Anchor-bolt templates keyed to specific poles and certified by manufacturer.
    2. Wiring Diagrams: Power and control wiring.

C. Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements in AASHTO LTS-4 and that load imposed by luminaire has been included in design.

D. Qualification Data: For agencies providing photometric data for lighting fixtures.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For luminaires and poles to include in emergency, operation, and maintenance manuals.

G. Warranty: Special warranty specified in this Section.

1.6 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

C. Comply with IEEE C2, "National Electrical Safety Code."

D. Comply with NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store poles on decay-resistant-treated skids at least 12 inches (300 mm) above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.

B. Retain factory-applied pole wrappings on metal poles until right before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.
   1. Warranty Period for Luminaires: Five years from date of Substantial Completion.
   2. Warranty Period for Metal Corrosion: Five years from date of Substantial Completion.
   3. Warranty Period for Color Retention: Five years from date of Substantial Completion.
   4. Warranty Period for Lamps: Replace lamps and fuses that fail within 12 months from date of Substantial Completion; furnish replacement lamps and fuses that fail within the second 12 months from date of Substantial Completion.
   5. Warranty Period for Poles: Repair or replace lighting poles and standards that fail in finish, materials, and workmanship within manufacturer's standard warranty period, but not less than three years from date of Substantial Completion.

1.9 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Lamps: Three of each type and rating installed. Furnish at least one of each type.
   2. Glass and Plastic Lenses, Covers, and Other Optical Parts: Three of each type and rating installed. Furnish at least one of each type.
   3. Ballasts: Three of each type and rating installed. Furnish at least one of each type.
   4. Globes and Guards: Three of each type and rating installed. Furnish at least one of each type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In Light Fixture Schedule on the Drawings where titles below are column or row headings that introduce lists, the following requirements apply to product selection:

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
2. Basis of Design Product: The design of each item of exterior luminaire and its support is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product by another manufacturer.

2.2 LUMINAIRES, GENERAL REQUIREMENTS

A. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.

B. Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.

C. Metal Parts: Free of burrs and sharp corners and edges.

D. Sheet Metal Components: Corrosion-resistant aluminum, unless otherwise indicated. Form and support to prevent warping and sagging.

E. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.

F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens. Contractor shall note in submittal any deviation from these requirements in specified and submitted luminaires.

G. Exposed Hardware Material: Stainless steel.

H. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

I. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:
   1. White Surfaces: 85 percent.
   2. Specular Surfaces: 83 percent.
   3. Diffusing Specular Surfaces: 75 percent.
   4. Notify the Design Professional of Record of any specified fixture which does not meet these minimum requirements.

J. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

K. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

L. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
   1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
   2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
      a. Color: As selected from manufacturer's standard catalog of colors.

2.3 BALLASTS FOR HID LAMPS

A. Comply with ANSI C82.4 and UL 1029 and capable of open-circuit operation without reduction of average lamp life. Include the following features, unless otherwise indicated:
   1. Ballast Circuit: Constant-wattage autotransformer or regulating high-power-factor type.
   2. Minimum Starting Temperature: Minus 22 deg F (Minus 30 deg C).
   3. Normal Ambient Operating Temperature: 104 deg F (40 deg C).
   4. Ballast Fuses: One in each ungrounded power supply conductor. Voltage and current ratings as recommended by ballast manufacturer.

2.4 HID LAMPS

A. Metal-Halide Lamps: ANSI C78.1372, with a minimum CRI 65, and color temperature 4000 K.

2.5 POLES AND SUPPORT COMPONENTS, GENERAL REQUIREMENTS

A. Structural Characteristics: Comply with AASHTO LTS-4.
   1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in Part 1 "Structural Analysis Criteria for Pole Selection" Article, with a gust factor of 1.3.
   2. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.

B. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts, unless otherwise indicated.

C. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.
   1. Materials: Shall not cause galvanic action at contact points.
   2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication, unless stainless-steel items are indicated.
   3. Anchor-Bolt Template: Plywood or steel.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

D. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete."

2.6 STEEL POLES

A. Poles: Comply with ASTM A 500, Grade B, carbon steel with a minimum yield of 46,000 psig (317 MPa); 1-piece construction up to 40 feet (12 m) in height with access handhole in pole wall.
   1. Shape: Square, tapered.
   2. Mounting Provisions: Butt flange for bolted mounting on foundation.

B. Steel Mast Arms: As indicated on the Drawings; continuously welded to pole attachment plate. Material and finish same as pole.

C. Brackets for Luminaires: Detachable, cantilever, without underbrace.
   1. Adapter fitting welded to pole and bracket, then bolted together with stainless- steel bolts.
   2. Cross Section: Tapered oval, with straight tubular end section to accommodate luminaire.
   3. Match pole material and finish.

D. Hinged pole base.

E. Grounding and Bonding Lugs: Welded 1/2-inch (13-mm) threaded lug, complying with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

F. Cable Support Grip: Wire-mesh type with rotating attachment eye, sized for diameter of cable and rated for a minimum load equal to weight of supported cable times a 5.0 safety factor.

G. Prime-Coat Finish: Manufacturer's standard prime-coat finish ready for field painting.

H. Factory-Painted Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
   1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
   2. Interior Surfaces of Pole: One coat of bituminous paint, or otherwise treat for equal corrosion protection.
   3. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
      a. Color: As indicated on the Drawings.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2.7 POLE ACCESSORIES

A. Duplex Receptacle: 120 V, 20 A in a weatherproof assembly complying with Division 26 Section "Wiring Devices" for ground-fault circuit-interrupter type.
   1. Recessed, 30 inches above finished grade where indicated on the Drawings.
   2. Nonmetallic polycarbonate plastic or reinforced fiberglass cover, dark bronze, that when mounted results in NEMA 250, Type 4X enclosure.
   3. With cord opening.
   4. With lockable hasp and latch that complies with OSHA lockout and tag-out requirements.

B. Base Covers: Manufacturers' standard metal units, arranged to cover pole's mounting bolts and nuts. Finish same as pole.

PART 3 - EXECUTION

3.1 LUMINAIRE INSTALLATION

A. Install lamps in each luminaire.

B. Fasten luminaire to indicated structural supports.

C. Adjust luminaires that require field adjustment or aiming. Document that all design lighting levels have been achieved after adjustments.

3.2 POLE INSTALLATION

A. Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.

B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features, unless otherwise indicated on Drawings:
   1. Fire Hydrants and Storm Drainage Piping: 60 inches (1520 mm)].
   2. Water, Gas, Electric, Communication, and Sewer Lines: 10 feet (3 m).
   3. Trees: 15 feet (5 m).

C. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Division 03 Section "Cast-in-Place Concrete."

D. Foundation-Mounted Poles: Mount pole with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer.
   1. Grout void between pole base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space.
   2. Install base covers, unless otherwise indicated.
   3. Use a short piece of 1/2-inch- (13-mm-) diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

E. Raise and set poles using web fabric slings (not chain or cable).

3.3 GROUNDING

A. Ground metal poles and support structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."
   1. Install grounding electrode for each pole, unless otherwise indicated.
   2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

B. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

B. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.
   1. Verify operation of photoelectric controls.

C. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

D. Test each fixture for a period of 72 hours total burning time. Replace all defective ballasts or erratic lamps encountered and retest for 24 hours.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain luminaire lowering devices. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes video surveillance system consisting of cameras, data transmission wiring, and a control station with its associated equipment.

1.3 CERTIFICATIONS AND STANDARDS

A. The camera shall carry the following EMC approvals:
   1. EN55022, EN55024
   2. FCC Part 15 - Subpart B
   3. VCCI
   4. C-tick AS/NZS 3548
   5. ICES-003

B. The camera shall meet the following standards
   1. MPEG-4:
      a. ISO/IEC 14496-2 (Profiles ASP and SP) or ISO/IEC 14496-10 AVC
   2. Networking:
      a. IEEE 802.3af (Power over Ethernet)
      b. IEEE 802.1X (Authentication)
      c. IPv4 (RFC 791)
      d. IPv6 (RFC 2460)
      e. QoS – DiffServ (RFC 2475)

1.4 SUBMITTALS

A. Product Data: For each type of product indicated, including dimensions and data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: Detail assemblies of standard components that are custom assembled for specific application on this Project.
   1. Functional Block Diagram: Show single-line interconnections between components for signal transmission and control. Show cable types and sizes.
   2. Wiring Diagrams: Power, signal, and control wiring, and grounding.

C. Equipment List: Include every piece of equipment by model number, manufacturer, serial number, location, and date of original installation. Add pretesting record of each piece of equipment, listing name of person testing, date of test, set points of adjustments, name and description of the view of preset positions, description of alarms, and description of unit output responses to an alarm.

D. Field quality-control test reports.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

E. Warranty: 3-year warranty.

1.5 QUALITY ASSURANCE

A. All camera installation, setup, program and related work shall be performed by electronic technicians thoroughly trained by the manufacturer in the installation and service of the equipment provided.

B. All equipment provided shall be backed by a minimum 3-year manufacturer's warranty.

1.6 PROJECT CONDITIONS

A. Environmental Conditions: Capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
   1. Interior, Uncontrolled Environment: System components installed in non-air-conditioned interior environments shall be rated for continuous operation in ambient temperatures of 0 to 122 deg F dry bulb and 20 to 90 percent relative humidity, noncondensing. NEMA 250, Type 12 enclosures.
   2. Exterior Environment: System components installed in locations exposed to weather shall be rated for continuous operation in ambient temperatures of minus 30 to plus 122 deg F dry bulb and 20 to 90 percent relative humidity, condensing. Rate for continuous operation when exposed to rain as specified in NEMA 250, winds up to 85 mph. NEMA 250, Type 4X enclosures.
   3. Hazardous Environment: System components located in areas where fire or explosion hazards may exist because of flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers shall be rated, listed, and installed according to NFPA 70.
   4. Corrosive Environment: System components subjected to corrosive fumes, vapors, and wind-driven salt spray in coastal zones. NEMA 250, Type 4X enclosures.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 SYSTEM REQUIREMENTS

A. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor entry connection to components.
   1. Minimum Protection for Power Connections 120 V and More: Auxiliary panel suppressors complying with requirements in Division 26 Section "Transient-Voltage Suppression."

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2.3 STANDARD CAMERAS

A. Indoor Fixed
1. General
a. The camera shall:
1) Be designed to provide simultaneous Motion JPEG and MPEG-4 video, and support resolutions up to 640x480 pixels.
2) Be designed to provide video at 30 frames per second for all resolutions.
3) Operate on an open source; Linux-based platform, and including a built-in web server.
4) Be manufactured with a tamper resistant polycarbonate casing
2. Hardware
a. The camera shall:
1) Use a high quality 1/4" progressive scan sensor.
2) Be fitted with a high quality F1.3 Varifocal DC-iris lens and provide pictures down to 1 lux at F1.3.
3) Be equipped with a built-in microphone.
3. Processor functionality
a. The camera shall:
1) Use a dedicated compression chip, and be equipped with a minimum of 8MB Flash memory and 32MB Random Access Memory (RAM).
2) Provide 9 MB memory for pre & post alarm recordings.
3) Be able to provide a total data throughput of up to 20Mbit/s on the network port.
4. Video
a. Resolution
1) The camera shall be able to deliver high-quality video in at least 15 different resolutions up to 640x480 pixels over IP networks.
2) Supported video resolutions shall include:
a) 160 x 120
b) 320 x 240
c) 640 x 480 (VGA)
b. Transmission speed
1) The camera shall allow the transmission of images at up to 30 frames per second in all resolutions.
c. Compression
1) The camera shall provide simultaneous support for both Motion JPEG and MPEG-4.
2) The MPEG-4 implementation shall include support for both Constant Bit Rate (CBR) and Variable Bit Rate (VBR), and shall support both unicast as well as multicast over RTP.
3) The camera shall provide at least 11 different compression levels.
4) The camera shall be capable of providing bit rates between 1kbps and 12 Mbps per video stream.
d. Image control
1) The camera shall incorporate Automatic and Manual White Balance and an electronic shutter operating in the range 1/4 and 1/15000 second.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

5. Audio
   a. The camera shall support half duplex audio using G.711or G.726 compression.
   b. The camera shall be capable of providing 8-bit audio at up to 64Kbit/sec.
6. Functionality
   a. Web server
      1) The camera shall contain a built-in web server making video and configuration available in a standard browser environment using HTTP, without the need for additional software.
      2) When accessed from a browser, the built-in web server shall provide users with online, context-sensitive help.
      3) The camera shall not require any additional software to operate, and shall support full functionality when operating in the following environment:
         a) Operating Systems: Windows 2000, Windows XP
         b) Browsers: MS Explorer 6.x and higher
      4) Components such as Active X downloaded from the camera shall be signed by an organization providing digital trust services, such as Verisign, Inc.
      5) The camera shall support simultaneous viewing by up to 20 clients from the web server.
      6) The camera's integral web server shall provide support for defining usernames and passwords, for a minimum of three different types of users.
   b. IP addresses
      1) The camera shall support both fixed IP addresses and dynamically assigned IP addresses provided by a Dynamic Host Control Protocol (DHCP) server.
      2) The camera shall allow for automatic detection of the camera based on UPnP and Bonjour when using a PC with an operating system supporting this feature.
      3) The camera shall provide support for both IPv4 and IPv6.
   c. Bandwidth management
      1) The camera shall
         a) Provide the ability to control network traffic by limiting the maximum bandwidth to a selected value.
         b) Provide the capability to limit the frame rate per viewer to a selected value, as well as the duration of each viewing session.
         c) Support Quality of Service (QoS) to be able to prioritize traffic.
   d. Event functionality
      1) The camera shall be equipped with an integrated event functionality, which can be trigged by:
         a) External inputs
         b) Video Motion Detection
         c) Audio Detection
         d) Schedule
      2) Response to triggers shall include:
         a) Notification, using TCP, SMTP or HTTP
         b) Image upload, using FTP, SMTP or HTTP
         c) Activating external output
      3) Event functions shall be configurable via the web interface.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

e. Protocol support
   1) The camera shall incorporate support for at least IP, HTTP, HTTPS, SSL/TLS, TCP, ICMP, SNMPv1/v2c/v3 (MIB-II), RTSP, RTP, UDP, IGMP, RTCP, SMTP, FTP, DHCP, UPnP, ARP, DNS, DynDNS, SOCKS, NTP and Bonjour.

f. Text overlay
   1) The camera shall:
      a) Provide embedded on-screen text in the video, with support for date & time, and a customer-specific text, camera name, of at least 45 ASCII characters. To ensure accuracy, the camera shall accept external time synchronization from an NTP (Network Time Protocol) server.
      b) Provide an ability to apply a privacy mask to the image, and shall allow for the overlay of a graphical image, such as a logotype, into the image.

g. Security
   1) The camera shall support the use of HTTPS and SSL/TLS, providing the ability to upload signed certificates to encrypt and secure authentication and communication of both administration data and video streams.
   2) Authentication shall be possible by using IEEE 802.1x.
   3) The camera shall provide support for restricting access to pre-defined IP addresses only, so-called IP address filtering.
   4) Access to the built-in web server shall be restricted by usernames and passwords.

h. API support
   1) The camera shall be fully supported by an open and published API (Application Programmers Interface), which shall provide necessary information for integration of functionality into third party applications.

i. Maintenance
   1) The camera shall:
      a) Be supplied with Windows-based management software which allows the assignment of IP addresses, upgrade of firmware and backup of the cameras configuration.
      b) Provide the ability to force-open the iris to improve the ability to adjust the cameras focus.
      c) Support the use of SNMP-based management tools according to SNMP v1, 2c & 3 / MIB-2.
      d) Allow updates of the software (firmware) over the network, using FTP or HTTP.
   2) Customer-specific settings, including statically assigned IP address, the local time & date, event functionality and video configuration, shall be stored in a non-volatile memory and shall not be lost during power cuts or soft reset.

7. Camera diagnosis
   a. The camera shall:
      1) Be equipped with a minimum of three LEDs, capable of providing visible status information in green, red and amber. LEDs shall indicate the

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

camera's operational status and provide information about power, communication with receiver, the network status and the camera status.

2) Be monitored by a Watchdog functionality, which shall automatically re-initiate processes or restart the unit if a malfunction is detected.

8. Interfaces
   a. Audio
      1) The camera shall be equipped with one 3.5mm jack for line/mic input and one 3.5mm jack for line out.
   b. Inputs/Outputs
      1) The camera shall be equipped with one digital (alarm) input and one digital output, accessible via a removable terminal block. This input shall be configurable to respond to normally open (NO) or normally closed (NC) dry contacts.
   c. Network interface
      1) The camera shall be equipped with one 100baseTX Fast Ethernet-port, using a standard RJ-45 socket and shall support auto sensing of network speed.
9. Enclosure
   a. The camera enclosure shall include the following:
      1) Manufactured with a polycarbonate casing
      2) Clear transparent cover
      3) Tamper resistant casing
   b. The camera enclosure shall provide the ability to adjust the camera modules angle with at least ±180° horizontal, ±85° vertical and ±170° rotation while maintaining an image that is not interfered with by the camera housing.
10. Power requirements
   a. Power over Ethernet according to IEEE802.3af - Class 1
   b. 4.9 - 5.1 VDC, max 3.6 W
11. Environmental
   a. The camera shall:
      1) Operate in a temperature range of 0°C to +50°C (32°F to +122°F), when using the built-in heater.
      2) Operate in a humidity range of 20–80% RH (non condensing).
12. Manufactured units
   a. The camera shall be an AXIS 216FD Fixed Dome Network Camera.
   b. Or approved equal

B. Outdoor PTZ Dome
   1. General
      a. The dome camera shall:
         1) Be designed to provide simultaneous Motion JPEG and MPEG-4 video, and support resolutions up to 704x480 pixels (NTSC) or 704x576 pixels (PAL).
         2) Be designed to provide video at 30 frames per second (NTSC) or 25 frames per second (PAL) for all resolutions using Motion JPEG.
         3) Provide high speed pan and tilt functions, contain so called day/night functionality and be equipped with 18x optical and 12x digital zoom.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

4) Operate on an open source, Linux-based platform, and include a built-in web server.
5) Be manufactured with an all-metal body.

2. Hardware
   a. The dome camera shall:
      1) Use a high quality IR-sensitive 1/4" CCD sensor.
      2) Be equipped with a removable IR-cut filter, providing so-called day/night functionality.
      3) Be equipped with a high quality F1.4 – F3.0 DC-iris lens with 18x optical zoom providing a horizontal angle of view between 48° and 2.8°.
      4) Provide pictures down to 0.3 lux at F1.4 while in day mode (with IR-filter in use) and down to 0.005 lux while in night mode (with IR-filter removed).
      5) Be equipped with accurate high-speed pan-tilt functionality with 360° endless pan range.
      6) Provide pan and tilt speed between 1.0° - 360°/second.
3. Processor functionality
   a. The dome camera shall:
      1) Use a dedicated video compression chip, and be equipped with a minimum of 8MB Flash memory and 32MB Random Access Memory (RAM).
      2) Provide 9 MB memory for pre & post alarm recordings.
      3) Be able to provide a total data throughput of up to 20Mbit/s on the network port.
4. Video
   a. Resolution
      1) The dome camera shall be able to deliver high-quality video in at least 5 different resolutions up to 704x480 pixels (NTSC) or 704x576 pixels (PAL) over IP networks.
      2) Supported video resolutions shall include:
         a) 176x120 (NTSC) / 176x144 (PAL)
         b) 352x240 (NTSC) / 352x288 (PAL)
         c) 704x480 (NTSC) / 704x576 (PAL)
   b. Transmission speed
      1) The dome camera shall allow the transmission of images at up to 30 frames per second (NTSC) or 25 frames per second (PAL) in all resolutions, using Motion JPEG.
   c. Compression
      1) The dome camera shall provide simultaneous support for both Motion JPEG and MPEG-4.
      2) The MPEG-4 implementation shall include support for both Constant Bit Rate (CBR) and Variable Bit Rate (VBR), and shall support both unicast as well as multicast over RTP.
      3) The dome camera shall provide at least 11 different compression levels.
      4) The dome camera shall be capable of providing bit rates between 1kbps and 12 Mbps per video stream.
   d. Image control
      1) The dome camera shall incorporate:
         a) Automatic Gain Control (AGC)

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

b) Automatic and Manual White Balance
c) Backlight compensation
d) Electronic shutter operating in the range 1 and 1/10.000 second

e. Image enhancement
1) The dome camera shall contain an embedded de-interlacing filter.

5. Functionality
a. Web server
1) The dome camera shall contain a built-in web server making video and configuration available in a standard browser environment using HTTP, without the need for additional software.
2) When accessed from a browser, the built-in web server shall provide users with online, context-sensitive help.
3) The dome camera shall not require any additional software to operate, and shall support full functionality when operating in the following environment:
a) Operating Systems: Windows 2000, Windows XP
b) Browsers: MS Explorer 6.x and higher
4) Components such as Active X downloaded from the dome camera shall be signed by an organization providing digital trust services, such as Verisign, Inc.
5) The dome cameras web server shall support up to 20 simultaneous unicast clients and unlimited number of clients using multicast MPEG-4.
6) The dome camera's integral web server shall provide support for defining usernames and passwords, for a minimum of three different types of users.

b. IP addresses
1) The dome camera shall support both fixed IP addresses and dynamically assigned IP addresses provided by a Dynamic Host Control Protocol (DHCP) server.
2) The dome camera shall allow for automatic detection of the dome camera based on UPnP and Bonjour when using a PC with an operating system supporting this feature.
3) The dome camera shall provide support for both IPv4 and IPv6.

c. Bandwidth management
1) The dome camera shall:
a) Provide the ability to control network traffic by limiting the maximum bandwidth to a selected value.
b) Provide the capability to limit the frame rate per viewer to a selected value, as well as the duration of each viewing session.
c) Support Quality of Service (QoS) to be able to prioritize traffic.

d. PTZ functionality
1) The dome camera shall:
a) Provide at least 80 preset positions.
b) Provide auto-flip functionality, which will automatically rotate the camera 180° when following a moving object passing under the dome.
c) Provide a guard tour functionality which allow the dome to automatically move between selected presets using an individual speed and viewing time for each preset.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

e. Event functionality
   1) The dome camera shall be equipped with an integrated event functionality, which can be trigged by:
      a) External inputs
      b) Video Motion Detection
      c) Preset position
      d) Schedule
   2) Response to triggers shall include:
      a) Notification, using TCP, SMTP or HTTP
      b) Image upload, using FTP, SMTP or HTTP
      c) Preset call up
      d) Activating external output
   3) Event functions shall be configurable via the web interface.

f. Protocol support
   1) The dome camera shall incorporate support for at least IP, HTTP, HTTPS, SSL/TLS, TCP, ICMP, SNMPv1/v2c/v3 (MIB-II), RTSP, RTP, UDP, IGMP, RTCP, SMTP, FTP, DHCP, UPnP, ARP, DNS, DynDNS, SOCKS, NTP and Bonjour.
   2) The SMTP implementation shall include support for SMTP authentication.

g. Text overlay
   1) The dome camera shall:
      a) Provide embedded on-screen text in the video, with support for date and time, and a customer-specific text, dome camera name, of at least 45 ASCII characters. To ensure accuracy, the dome camera shall accept external time synchronization from an NTP (Network Time Protocol) server.
      b) Allow for the overlay of a graphical image, such as a logotype, into the image.

h. Security
   1) The dome camera shall support the use of HTTPS and SSL/TLS, providing the ability to upload signed certificates to encrypt and secure authentication and communication of both administration data and video streams.
   2) Authentication shall be possible by using IEEE 802.1x.
   3) The dome camera shall provide support for restricting access to pre-defined IP addresses only, so-called IP address filtering.
   4) Access to the built-in web server shall be restricted by usernames and passwords.

i. API support
   1) The dome camera shall be fully supported by an open and published API (Application Programmers Interface), which shall provide necessary information for integration of functionality into third party applications.

j. Maintenance
   1) The dome camera shall:
      a) Be supplied with Windows-based management software which allows the assignment of IP addresses, upgrade of firmware and backup of the dome cameras configuration.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

b) Support the use of SNMP-based management tools according to SNMP v1, 2c & 3 / MIB-2.
c) Allow updates of the software (firmware) over the network, using FTP or HTTP.

2) Customer-specific settings, including statically assigned IP address, the local time & date, event functionality and video configuration, shall be stored in a non-volatile memory and shall not be lost during power cuts or soft reset.

6. Dome camera diagnostics
   a. The dome camera shall:
      1) Be equipped with LEDs, capable of providing visible status information. These LEDs shall indicate the dome camera's operational status and provide information about power, communication with receiver, the network status and the dome camera status.
      2) Be monitored by a Watchdog functionality, which shall automatically re-initiate processes or restart the unit if a malfunction is detected.
7. Interfaces
   a. Multifunctional connector
      1) The unit shall be equipped with a separate connection box, which connect to the dome camera using a "multi wire cable". This connection box shall, using removable terminal blocks, provide connectivity for:
         a) Four digital (alarm) inputs and four digital outputs. These inputs shall be configurable to respond to normally open (NO) or normally closed (NC) dry contacts.
         b) Power
   b. Network interface
      1) The dome camera shall be equipped with one 100baseTX Fast Ethernet-port, using a standard RJ-45 socket and shall support auto sensing of network speed.
8. Enclosure
   a. The dome camera enclosure shall be the following:
      1) Axis T95A00 Series Dome Housing
      2) Or approved equal
9. Power requirements
   a. 120 V AC to dome housing
10. Environmental
    a. The dome camera shall:
       1) Operate in a temperature range of -4°F to +122°F.
11. Manufactured units
    a. The dome camera shall be an AXIS 232D+ Network Dome Camera.
    b. Or approved equal

2.4 CAMERA-SUPPORTING EQUIPMENT

A. Mounting Brackets for Fixed Cameras: Type matched to items supported and mounting conditions. Include manual pan-and-tilt adjustment.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Protective Housings for Fixed and Movable Cameras: Aluminum enclosures with internal camera mounting and connecting provisions that are matched to camera/lens combination and mounting and installing arrangement of camera to be housed.

2.5 MONITORS

A. Monitors are to be provided by the Owner:

2.6 DIGITAL VIDEO RECORDERS

A. Digital video recorders are to be provided by the Owner.

2.7 CONTROL STATIONS

A. Control stations are to be provided by the Owner.

2.8 CONTROL STATION SOFTWARE

A. System supplier shall provide the following software to Owner
   1. Axis Camera Station Software
   2. Axis Camera Management Software
   3. Axis MPEG-4 Decoder License Pack (if required)

B. System supplier shall install software on owner supplied control station and integrate cameras into a useful control atmosphere acceptable by owners. Supplier shall request of owner in design of control atmosphere in order to meet expectations.

PART 3 - EXECUTION

3.1 VIDEO SURVEILLANCE SYSTEM INSTALLATION

A. The Contractor shall carefully follow instructions in documentation provided by the manufacturer to insure all steps have been taken to provide a reliable, easy-to-operate system.

B. All equipment shall be tested and configured in accordance with instructions provided by the manufacturer prior to installation.

C. All firmware found in products shall be the latest and most up-to-date provided by the manufacturer, or of a version as specified by the provider of the Video Management Application (VMA) or Network Video Recorder (NVR).

D. All equipment requiring users to log on using a password shall be configured with user/site-specific password/passwords. No system/product default passwords shall be allowed.

3.2 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation and supervise pretesting, testing, and adjusting of video surveillance equipment.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Inspection: Verify that units and controls are properly installed, connected, and labeled, and that interconnecting wires and terminals are identified.

C. Pretesting: Align and adjust system and pretest components, wiring, and functions to verify that they comply with specified requirements. Conduct tests at varying lighting levels, including day and night scenes as applicable. Prepare video surveillance equipment for acceptance and operational testing as follows:
   1. Prepare equipment list described in Part 1 "Submittals" Article.
   2. Verify operation of auto-iris lenses.
   3. Set back-focus of fixed focal length lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Adjust until image is in focus with and without the filter.
   4. Set back-focus of zoom lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Additionally, set zoom to full wide angle and aim camera at an object 50 to 75 feet (17 to 23 m) away. Adjust until image is in focus from full wide angle to full telephoto, with the filter in place.
   5. Set and name all preset positions; consult Owner's personnel.
   6. Set sensitivity of motion detection.
   7. Connect and verify responses to alarms.
   8. Verify operation of control-station equipment.

D. Test Schedule: Schedule tests after pretesting has been successfully completed and system has been in normal functional operation for at least 14 days. Provide a minimum of 10 days' notice of test schedule.

E. Operational Tests: Perform operational system tests to verify that system complies with Specifications. Include all modes of system operation. Test equipment for proper operation in all functional modes.

F. Remove and replace malfunctioning items and retest as specified above.

G. Record test results for each piece of equipment.

H. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.

3.3 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions and to optimize performance of the installed equipment. Tasks shall include, but are not limited to, the following:
   1. Check cable connections.
   2. Check proper operation of cameras and lenses. Verify operation of auto-iris lenses and adjust back-focus as needed.
   3. Adjust all preset positions; consult Owner's personnel.
   4. Recommend changes to cameras, lenses, and associated equipment to improve Owner' utilization of video surveillance system.
   5. Provide a written report of adjustments and recommendations.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3.4 CLEANING

A. Clean installed items using methods and materials recommended in writing by manufacturer.

B. Clean video surveillance system components, including camera-housing windows, lenses, and monitor screens.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain video surveillance equipment.
   1. Train Owner's maintenance personnel on procedures and schedules for troubleshooting, servicing, and maintaining equipment.
   2. Demonstrate methods of determining optimum alignment and adjustment of components and settings for system controls.
   3. Review equipment list and data in maintenance manuals. Refer to Division 01 Section "Operation and Maintenance Data"
   4. Conduct a minimum of eight hours' training total, divided into two courses of four hours.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes excavation of all materials encountered, including earth, rock or other materials, whether wet or dry. The Contractor shall dispose of all excavated materials to the lines and grades shown on the Drawings or as directed elsewhere in the specifications.

B. Provide necessary sheeting, shoring, bracing, and timbering necessary for the proper protection and safety of the work, workmen, public, and any adjacent properties.

C. Dewater excavation as required.

D. Undercut unsuitable materials and replace as required. Dispose of any unsuitable or excess materials.

E. Prepare a stable, satisfactory trench bottom.

F. Place and compact granular beds, check dams, and backfill as appropriate.

G. Finish grading and site cleanup. Cleanup shall follow in close succession to other construction activities and shall be a daily function. The concept of leaving cleanup until the other construction is completed is not acceptable. The Owner reserves the right to withhold payments (in part or in whole) if cleanup and restoration does not meet with the approval of the Owner.

H. Patching of pavement, repairing and/or reinstalling all public and private improvements disturbed by the construction and the spreading and shaping of topsoil to the finished contour elevations indicated by the drawings. Allowances will be made for time of settling of backfilled trenches before final grading and landscaping is attempted; however, drainage ditches are not to be left obstructed.

I. Materials excavated shall be unclassified. No additional payment shall be made for changes in subsurface conditions.

1.3 REFERENCE STANDARDS

A. ASTM C33 - Concrete Aggregate.

B. ASTM C136 - Sieve Analysis of Fine and Coarse Aggregates.

C. ASTM D698 - Moisture-Density Relations of Soils and Soil-Aggregate Mixtures, Using 5.5 lb. Rammer and 12 inch Drop.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

D. ASTM D1117 - Testing Non-Woven Fabrics.

E. ASTM D1556 - Density of Soil in Place by the Sand-Cone Method.

F. ASTM D1557 - Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10 lb. Rammer and 18 inch Drop.

G. ASTM D2922 - Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

H. ASTM D3786 - Hydraulic Bursting Strength of Non-woven Fabrics - Diaphragm Bursting Strength.

I. ASTM D4632 - Breaking Load and Elongation of Textile Fabrics.

J. ASTM D4833 - Bursting Strength of Knitted Goods - Ball Burst Test.

1.4 DEFINITIONS

A. Rock: Rock is defined as stone or hard shale in original ledge or masses and boulders over one-half (1/2) cubic yard in volume that cannot be excavated with a backhoe having a bucket curling force rated at not less than 24,700 pounds (Caterpillar Model 215 or equivalent). Material which can be loosened with a pick, frozen materials, shale and hardpan which for convenience or economy is loosened by drilling and blasting or by drilling coupled with wedging and material which is exterior to the limits of measurement allowed shall not be measured or classified as rock excavation.

B. Rock Excavation: Any rock as defined above, concrete with reinforcement, stone or brick masonry which are required to be removed in order to complete the work under this Contract will be considered as rock excavation. Curbs, sidewalk slabs, pavement, pavement foundations, manholes, pipe bulkheads and materials which can be moved without extensive breakage will not be considered as rock.

C. Fill: General term for all materials used to raise existing grades.

D. Backfill: All fill material placed immediately behind retaining walls.

E. Drainage Course: Capillary water barrier layer below slab-on-grade.

F. Structural Fill: All fill material under building pad.

G. Borrow: Satisfactory soil imported from off-site for use as fill.

H. Building Pad: The building pad for the structure is the building footprint and extending 10 feet outside the perimeter of the building.

I. Excavation: Removal of material encountered above subgrade elevations.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1. Additional Excavation: Excavation below subgrade elevations as directed by Engineer. Additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
2. Bulk Excavation: Excavations more than 10 feet (3 m) in width and pits more than 30 feet (9 m) in either length or width.
3. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated dimensions without direction by the Engineer. Unauthorized excavation, as well as remedial work directed by the Engineer, shall be without additional compensation.

J. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

K. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or structural fill immediately below drainage course, or topsoil materials.

1.5 QUALITY ASSURANCE

A. Codes and Standards: Perform excavation work in compliance with applicable requirements of governing authorities having jurisdiction.

B. Regulatory Requirements: Comply with water disposal requirements of authorities having jurisdiction.

C. Comply with applicable requirements of NFPA 495, "Explosive Materials Code."

D. Testing Agency Qualifications: An independent testing agency, acceptable to the Owner and Engineer, and qualified according to ASTM E 329, is to conduct field quality control and soil materials and rock-definition testing, as documented according to ASTM D 3740 and ASTM E 548.

E. Preexcavation Conference: Conduct pre-excavation conference at Project site that complies with requirements in Division 01.

F. Prior to construction, have structure location staked and certified by a licensed surveyor in the State of Kentucky. If discrepancies between actual lines and elevations exist, notify the Engineer before proceeding with layout of building.

1.6 SUBMITTALS

A. Material Test Reports: The Testing Agency providing the material test reports will indicate and interpret results for compliance with the following requirements:
1. Classification according to ASTM D 2487 of each on-site or borrow soil material proposed for fill.
2. Laboratory compaction curve according to ASTM D 698 for each on-site or borrow soil material proposed for fill.

B. Specifications for the vibratory compaction equipment.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1.7 PRECAUTIONS

A. In accordance with the Kentucky State Law (Kentucky Underground Protection), the Contractor shall properly notify underground utility owners prior to beginning excavation activities. Kentucky State Law requires notification to the statewide one-call center, Kentucky One-Call, at least three (3) working days prior to excavation, but not more than ten (10) working days in advance of beginning the work. Locate requests, including emergency locate requests, to Kentucky One-Call shall be processed in accordance with Kentucky State Law. Contact Kentucky One-Call at 811 or 1-800-752-6007 to process a locate ticket.

B. Protect all structures, utilities, sidewalks, pavements, fences, vegetation and other features to remain. Protect from damage caused by settlement, lateral and vertical movement, undermining, washout, and other hazards created by earthwork operations.

C. Protect all benchmarks, property pins, survey points and similar items. If disturbed or damaged by construction operations, the Contractor shall pay the cost of restoration by a registered surveyor.

D. Follow all Federal, State, County, TVA, KYTC, and Railroad regulations when working in Rights-of-Way not owned by City or in utility easement.

E. Establish all erosion prevention and sediment control devices.

F. Precautions shall be taken to eliminate tracking of soil, mud, rock and gravel onto streets and roadways.

G. Protect excavations by shoring, bracing, sheet piling, underpinning, or other methods required to prevent cave-in or loose soil from falling into excavation.

H. Underpin adjacent structures which may be damaged by excavation work, including service utilities and pipe chases.

I. Notify Owner of unexpected subsurface conditions and discontinue work in affected area until notification to resume work.

J. Grade excavation top perimeter to prevent surface water run-off into excavation.

K. Protect excavation bottoms, adjacent soils, and foundations against freezing and frost when atmospheric temperature is less than 35^{o}F.

L. Protect trees, shrubbery, fences, poles, and all other property and surface structures during construction operations unless their removal for purposes of construction is authorized by Owner. Fences, poles, or other man made surface improvements which are moved or disturbed shall be restored to the original conditions after construction is completed. Trees, shrubbery, or other vegetation which are approved for removal in order to facilitate construction operations shall be removed completely, including stumps and main roots. Responsibility for damage or claims for damage caused by construction operations to shrubbery or other landscape improvements which were not authorized for removal by the Owner shall be assumed by the Contractor.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1.8 DUST CONTROL

A. When ordered by Engineer or his representative, furnish and distribute over traveled road surfaces which have not been fully restored an application of regular flake calcium chloride having a minimum calcium chloride content of 77 percent, or a brine solution consisting of 1.5 pound of calcium chloride and one pound of sodium chloride per 100 gallons of water applied by a pressure distributor. Rate of application shall be 3 pounds/square yard for the flake calcium chloride, and 0.48 gallon/square yard for brine solution.

B. Whenever dust control is necessary, it shall be considered an integral part of the work, and no separate payment shall be made for it.

1.9 PROJECT CONDITIONS

A. Existing Utilities: Locate existing underground utilities in areas of work. If utilities are to remain in place, provide adequate means of support and protection during earthwork operations.

B. Should uncharted (or incorrectly charted) piping or other utilities be encountered during excavation, consult utility owner immediately for directions. Cooperate with Owner and utility companies in keeping respective services and facilities in operation. Repair damaged utilities to satisfaction of utility owner.

C. Interruption of Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Engineer and then only after arranging to provide temporary utility services according to requirements indicated:
   1. Notify Engineer not less than two days in advance of proposed utility interruptions.
   2. Do not proceed with utility interruptions without Engineer's written permission.
   3. Contact utility-locator service for area where Project is located before excavating.

D. Site Information: Data on indicated site conditions are not intended as representations or warranties of continuity of such conditions. It is expressly understood that Owner will not be responsible for interpretations or conclusions drawn there from by Contractor. Data are made available for convenience of Contractor and are not guaranteed to represent conditions that may be encountered.

E. Subsurface Conditions: A subsurface investigation has not been performed at the Project site. Neither the Owner nor the Engineer are responsible for subsurface conditions. The Contractor shall make his own determination prior to bidding concerning the characteristics of any groundwater and subsurface soils to be encountered at the Project site.

F. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies for shut-off of services if lines are active.

G. Use of Explosives: Do not bring explosives onto site or use in work.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials and products used for repair and/or replacement of disturbed areas shall meet or exceed the type and quality of the original.

2.2 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. The testing service shall be on-site to determine satisfactory and unsatisfactory soils materials. In general the following apply:
   1. Satisfactory soil materials are defined as those complying with ASTM D2487 unified soil classification system groups GW, GP, GM, SM, SW and SP.
   2. Unsatisfactory soil materials are defined as those complying with ASTM D2487 unified soil classification system groups GC, SC, ML, MH, CL, CH, OL, OH and PT.

C. Backfill and Fill Materials shall be satisfactory soil materials of clay, rock, shot rock, or gravel, free of debris, waste, frozen materials, vegetable and other deleterious matter. Do not place stone or shot rock greater than 4" in any dimension within 12" of subgrade elevation.

D. Drainage Fill: Washed, evenly graded mixture of crushed stone, or crushed or uncrushed gravel, with 100% passing a 1-1/2" sieve and not more than 5% passing a No. 4 sieve.

2.3 BEDDING AND BACKFILL MATERIALS

A. Class I Material: Angular, 1/4 to 1 inch graded stone.

B. Class II Material: Coarse sands and gravels with a maximum particle dimension of 1-1/2 inch including variously graded sands and gravels containing small percentages of fines, generally granular and non-cohesive, either wet or dry.

C. Class III Material: Fine sand and clayey gravels, including fine sands, sand-clay mixtures, and gravel-clay mixtures.

D. Class IV Material: Silt, silty clays, and clays, including inorganic clays and silts of medium to high plasticity and liquid limits.

E. In rock cuts, paved areas, roadways or other areas where free drainage bedding or backfill material is required, use Class I angular material.

2.4 TOPSOIL

A. Use stripped topsoil that has been stockpiled as specified. If the quantity of topsoil on the job is inadequate, furnish enough additional topsoil. Topsoil furnished shall be natural, fertile, friable soil possessing characteristics of representative productive soils in the vicinity. It shall be obtained from naturally well drained areas. It shall not be excessively acid or alkaline nor

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

contain toxic substances that may be harmful to plant growth. Topsoil shall be without admixture of subsoil and shall be cleaned and reasonably free from clay lumps, stones, stumps, roots, or similar substances 2 inches or more in diameter, debris, or other objects that are a hindrance to planting operations. Such material shall be subject to testing.

2.5 ACCESSORIES

A. Soil Stabilization Fabric For Pavement Subgrade Strengthening: A woven fabric composed of a stable network of polypropylene yarns. The fabric shall be inert to biological degradation and naturally encountered chemicals, alkalies, and acids. The fabric shall conform to the following minimum property values:
   1. Grab Tensile Strength - 250 lb. - ASTM D4632-86.
   2. Grab Tensile Elongation - 30% (maximum) - ASTM D4632-86.
   3. Burst Strength - 500 psi - ASTM D3786-80a.
   4. Trapezoidal Tear Strength - 115 lb. - ASTM D1117-80.
   5. Puncture Resistance - 150 lb. - ASTM D4833-88.
   6. Modulus (load at 10% elongation) - 105 lb. - ASTM D4632-82.
   7. Coefficient of Permeability .001 cm/sec.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork and dewatering operations.

B. Protect subgrades and foundation soils against freezing temperatures or frost. Provide protective insulating materials as necessary.

C. Provide erosion-control measures, as specified in Division 31 Section "Erosion and Sediment Control," to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

D. Prevent surface water and subsurface or ground water from entering excavations, from ponding on prepared subgrades, and from flooding site and surrounding area.

E. Protect subgrades and foundation soils from softening and damage by rain or water accumulation.

F. Before starting construction, remove from the work site all vegetable growth (except as hereinafter excluded), debris, and/or other objectionable matter as well as any buildings and/or other structures that the Owner specifically indicates are to be removed. Dispose of this refuse material in a manner acceptable to the Owner.

G. In certain areas it may be desirable for existing trees, shrubs, or other vegetation on the site to be preserved for the permanent landscape. Such vegetation may be specifically listed in the specifications, marked on the site, or identified by the Owner. In no case damage or remove such growth without written permission from the Owner.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

H. If the area to be excavated is occupied by trees, brush, or other vegetable growth, clear such growth and grub the excavated area, and remove all large roots to a depth of not less than 2-feet below the bottom of the proposed construction. Dispose of the growth removed in a manner satisfactory to the Owner. Fill all holes or cavities created during this work that extend below the subgrade elevation with suitable material, and compact to the same density as the surrounding material.

I. Trees, cultivated shrubs, etc., that are situated within public rights-of-way and/or construction easements through private property but not directly within the excavation area shall remain undisturbed unless it is necessary to remove them so that the work can be performed safely and unless their removal is specifically ordered by the Owner. Take special precautions to protect and preserve such growth throughout all stages of the construction.

J. Protect all features to remain.

3.2 EXCAVATION

A. Excavation is Unclassified, and includes excavation to subgrade elevations regardless of character of materials and obstructions encountered. It shall be understood that any reference to rock, earth, or any other material on the drawings is not to be taken as an indication of classified excavation or the quantity of either rock, earth, or any other material involved.

B. The bidder shall draw his own conclusions as to the conditions to be encountered. When rock borings, soundings or test pit data are provided, they are for information only and do not guarantee existing conditions.

C. Align the trench as shown on the Contract Drawings. Deviations due to obstructions are included in this Section.

D. Perform excavation in such a manner as to form a suitable trench in which to place the pipe and so as to cause the least inconvenience to the public.

E. The Contractor shall be responsible for stripping, storing, and protecting topsoil to be removed prior to excavation. This topsoil is to be reused during cleanup and restoration. The Contractor is responsible for obtaining and providing other topsoil as may be necessary to restore excavated area to its original topsoil quantity and quality.

F. Pavement cuts shall be made along neat, straight lines with either a pavement breaker or pavement saw prior to the excavation. Cut pavement to be a minimum of 6 inches outside of trench cut.

G. Trenches shall be excavated to the depths indicated on the Contract Drawings. Trench depth shall be sufficient to provide a minimum cover of 36 inches over the top of the pipe in non-traffic areas and 48 inches in areas subject to vehicular traffic. Depth of cover is measured from finished grade to top of the pipe. Where approved by the Owner, additional pipe protection such as use of ductile iron pipe or concrete encasement may be used where minimum cover is not possible. Increased depth may be required as noted on the Contract Drawings to avoid obstructions, avoid requiring an air release valve and other reasons.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

H. Excavated material shall be placed a minimum of two feet back from the edge of the trench.

I. When unstable soil or other unsuitable material is encountered at the trench bottom, undercut these materials to a depth required to assure support of the pipeline or as directed by the Engineer and backfill to the proper grade with compacted crushed stone. The top 6 inches shall be Class I angular material.

J. Remove rock encountered in trench excavation to a minimum depth of 6 inches below the bottom of the pipe barrel, backfill with Class I angular material, and compact to uniformly support the pipe. In no case shall solid rock exist within six inches of the finished pipeline.

K. Maximum width at the crown of the pipe shall be 2 feet plus the nominal diameter of the pipe, unless specifically approved otherwise by the Engineer due to unusual bracing and shoring requirements. Trenches constructed by mechanical trenching are allowed only with prior approval of Engineer. Over-excavation will be required at locations for fittings and valves and construction of concrete thrust blocks.

L. Trenches 4 feet or more in depth should be provided with a means of egress. Spacing between ladders or other means of egress must be such that a worker will not have to travel more than 25 feet laterally to the nearest means of egress.

M. Open excavations shall be barricaded when the Contractor is not at the site. At a minimum, this shall consist of orange polyethylene barricade safety fence.

N. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work. Remove soft or loose zones encountered in the bottom of footing. Provide compacted fill as directed by Geotechnical Engineer.

O. Pile Foundations: Stop excavations from 6 to 12 inches (150 to 300 mm) above bottom of pile cap before piles are placed. After piles have been placed, remove loose and displaced material. Excavate to final grade, leaving solid base to receive concrete pile caps. Remove soft or loose zones encountered in the bearing surface. Provide compacted fill as directed by the Geotechnical Engineer.

P. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1 inch (25 mm). Do not disturb bottom of excavations intended for bearing surface.

3.3 EXISTING UTILITIES

A. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies to shut off services if lines are active.

B. Locate existing utilities by careful hand excavation. If utilities are to remain in place, provide protection from damage during construction operations.

C. Should uncharted or incorrectly charted utilities be encountered during excavation, consult the Engineer immediately for directions.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

D. Repair damaged utilities that are to remain or those damaged prior to when scheduled to be taken out of service to the satisfaction of the Owner.

3.4 SHEETING, SHORING AND BRACING

A. Furnish, put in place, and maintain such sheeting, shoring and bracing, as may be required to support the sides of the excavation and to prevent movement as required by OSHA. Damages resulting from improper shoring or failure to shore shall be the sole responsibility of the Contractor.

B. Comply with all OSHA standards in determining where and in what manner sheeting, shoring and bracing are to be accomplished. The sheeting, shoring and bracing system shall be designed by a professional engineer licensed in the State of Kentucky and shall be subject to approval by the Engineer. However, such approval does not relieve the Contractor of the sole responsibility for the safety of all employees, the effectiveness of the system, and any damages or injuries resulting from the lack or inadequacy of the sheeting, shoring and bracing.

C. The Contractor may use a trench box, which is a prefabricated movable trench shield composed of steel plates welded to a heavy steel frame. The trench box shall be designed to provide protection equal to or greater than that of an appropriate shoring system.

D. Take special care to avoid damage wherever excavation is being performed. Sufficiently sheet, shore, and brace the sides of all excavations to prevent slides, cave-ins, settlement, or movement of the banks and to maintain the specified trench widths. Use solid sheets in wet, saturated, or flowing ground. All sheeting, shoring, and bracing shall have enough strength and rigidity to withstand the pressures exerted, to keep the walls of the excavation properly in place, and to protect all persons and property from injury or damage. Separate payment will not be made for sheeting, shoring, and bracing, which are considered an incidental part of the excavation work.

E. Wherever employees may be exposed to moving ground or cave-ins, shore and lay back exposed earth excavation surfaces more than 5-feet high to a stable slope, or else provide some equivalent means of protection. Effectively protect trenches less than 5-feet deep when examination of the ground indicates hazardous ground movement may be expected. Guard the walls and faces of all excavations in which employees are exposed to danger from moving ground by a shoring system, sloping of the ground, or some equivalent protection.

F. Where excavations are made adjacent to existing buildings or structures or in paved streets or alleys, take particular care to sheet, shore, and brace the sides of the excavation so as to prevent any undermining of or settlement beneath such structures or pavement. Underpin adjacent structures wherever necessary, with the approval of the Owner.

G. Fill and compact all holes and voids left in the work by the removal of sheeting, shoring, or bracing as specified herein.

H. Dewatering: Prevent surface water and subsurface or ground water from flowing into excavations and from flooding the project site and surrounding area.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

I. Do not allow water to accumulate in excavations. Remove water to prevent softening of subgrade foundation bottoms, undercutting footings, and soil changes detrimental to stability of subgrades and foundations. Provide and maintain pumps, well points, sumps, suction and discharge lines, and other dewatering system components necessary to convey water away from excavations.

J. Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey rain water and water removed from excavations to collecting or run-off areas. Do not use trench excavations as temporary drainage ditches.

3.5 DISPOSAL OF MATERIALS

A. Whenever practicable, all materials removed by excavation that are suitable for backfilling pipe trenches or for other purposes shown on the Contract Drawings or directed by the Engineer shall be used for those purposes.

B. Any materials not so used shall be considered waste materials and disposed of by the Contractor. Waste materials may be deposited in spoil areas at locations approved of by the Engineer, or shall be properly disposed of off-site if there is no approved spoil area. Do not leave in unsightly piles, but instead, spread in uniform layers, neatly level and shaped to drain.

3.6 UNAUTHORIZED EXCAVATION

A. Unauthorized excavation is defined as all excavation outside or below the proposed lines and grades shown on the Contract Drawings or that which is directed by the Engineer.

B. Backfill areas of unauthorized excavation with the type of material necessary to ensure the stability of the structure or construction involved.

3.7 PROOF ROLLING OPERATIONS

A. Proof roll the site after stripping or excavation, and before any fill placement, with two coverages of a loaded dump truck or scraper. Areas found to be soft or pumping shall have the soft soil removed and replaced with structural fill and compacted as outlined herein.

3.8 APPROVAL OF SUBGRADE

A. Notify Testing Agency when excavations have reached required subgrade.

B. If Testing Agency determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.
   1. Additional excavation and replacement material due to unforeseen conditions will be paid for according to Contract provisions for changes in the Work.
   2. Material rendered unsuitable due to noncompliance with project specifications and drawings shall be removed and replaced as directed by the Engineer at the Contractor's expense.

C. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Engineer.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3.9 BORROW EXCAVATION

A. Whenever the backfill of excavated areas or the placement of embankments requires more material than is available from authorized excavations, or whenever the backfill material from such excavations is unsuitable, then obtain additional material from other sources. This may require the opening of borrow pits at points accessible to the work. In such cases, make suitable arrangements with the property owner and pay all incidental costs, including any royalties, for the use of the borrowed material. Before a borrow pit is opened, the quality and suitability of its material shall be approved by the Owner.

B. Excavate borrow pits in such a way remaining surfaces and slopes are reasonably smooth and that adequate drainage is provided over the entire area. Construct drainage ditches wherever necessary to provide outlets for water to the nearest natural channel, thus preventing the formation of pools in the pit area. Leave sides of borrow pit cuts at a maximum slope of 2:1 unless otherwise directed by the Owner.

C. Properly clear and grub borrow pits, and remove all objectionable matter from the borrow pit material before placing it in the backfill.

D. The takings of materials from borrow pits for use in the construction of backfill, fills, or embankments shall be considered an incidental part of the work; no separate payment shall be made for this.

3.10 DEWATERING

A. The Contractor shall furnish, install and operate all necessary equipment to keep excavated areas free of water while work is in progress. Dewatering equipment shall be of adequate size and quantity to assure maintaining proper conditions for installing pipe, concrete, bedding, backfill or other material or structure in the excavation.

B. Well-pointing shall be performed if required.

C. Before excavating below ground-water level, place system into operation to lower water to specified levels. Operate system continuously until structures such as drains and sewers have been constructed and fill materials have been placed, or until dewatering is no longer required.

D. Provide an adequate system to lower and control ground water to permit excavation, construction of structures, and placement of fill materials on dry subgrades. Install sufficient dewatering equipment to drain water-bearing strata above and below bottom of foundations, drains, sewers, and other excavations.
   1. Do not permit open-sump pumping that leads to loss of fines, soil piping, subgrade softening, and slope instability.

E. Reduce hydrostatic head in water-bearing strata below subgrade elevations of foundations, drains, sewers, and other excavations.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

F. Provide standby equipment on-site, installed and available for immediate operation, to maintain dewatering on continuous basis if any part of system becomes inadequate or fails. If dewatering requirements are not satisfied due to inadequacy or failure of dewatering system, restore damaged structures and foundation soils at no additional expense to Owner.
   1. Remove dewatering system from Project site on completion of dewatering. Plug or fill well holes with sand or cut off and cap wells a minimum of 36 inches (900 mm) below overlying construction.

G. Take particular precautions to prevent the displacement of structures or pipelines as a result of accumulated water. Any pipe displaced due to accumulated water shall be replaced by the Contractor at his expense.

H. Dewatering operations shall be performed in a manner so as not to cause injury to public or private property or nuisance to the public nor contribute to pollution to surface water. The Contractor's dewatering operations shall be in full compliance with Division 31 Section "Erosion and Sediment Control" of these Specifications.

3.11 OBSTRUCTIONS

A. Obstructions shown on the Contract Drawings are for information only and do not guarantee their exact locations nor that other obstructions are not present. The crossing of existing mains and services, which are approximately perpendicular to the proposed ditch line, is considered normal construction practice. The Contractor shall have the responsibility of making these crossings and repairing any damages to such crossings without additional reimbursement.

B. Whenever unknown obstructions are encountered during the progress of the work that directly interfere with the vertical or horizontal alignment of the pipeline, the Engineer shall have the authority to order a deviation from the grade or alignment or for the removal, relocation or reconstruction of the obstructing utility or structure. Likewise, the Contractor may request to relocate the proposed line or request reimbursement for relocating the existing line or performing unusual shoring beyond what is normally required for trench stabilization.

C. When utilities or obstructions are not shown on the Contract Drawings but are present off the roadway at the location of the proposed pipeline route, the Contractor may request to relocate the pipeline in the roadway if necessary to avoid disturbing the utility or obstructions. If the relocation is approved by the Engineer into a paved area, the Contractor shall receive compensation for additional granular backfill and pavement replacement.

D. Exercise due care in excavating adjacent to existing obstructions and do not disturb unless supervised by Engineer or Owner.

E. In the event existing utilities are disturbed, repair or replace as quickly as possible to the condition existing prior to their disturbance at no cost to the Owner. The Contractor is responsible to pay for the repair or replacement work performed by the forces of the utility company or other appropriate party.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

F. If replacement or repair of disturbed obstructions is not performed after a reasonable period of time, the Owner may have the necessary work completed and deduct the cost incurred from payments to the Contractor.

3.12 BEDDING OF GRAVITY SEWER MAINS

A. Always maintain proper grade and alignment during the bedding and tamping process. Any pipe damaged or displaced during this process shall be replaced by the Contractor at his expense.

B. Provide a minimum of 6 inches of compacted Class I angular material for bedding of all gravity sanitary sewer pipe regardless of pipe material. Dig bell holes so that the barrel of the pipe will rest for its entire length upon the prepared bedding to assure uniform support of the pipe.

C. Where gravity sewer pipe, regardless of pipe material, is laid within a rock cut, completely encapsulate each pipe section with a minimum of 6 inches of Class I angular material on the top, both sides and the bottom of the pipe.

3.13 INITIAL BACKFILLING

A. Do not begin backfilling before the Engineer or his representative has inspected or approved the grade and alignment of the pipe, the bedding of the pipe, and the joints between the pipes. If backfill material is placed over the pipe before an inspection is made, the Engineer or his representative may require the Contractor to reopen the trench in order for an inspection to be made at no cost to the Owner.

B. Perform initial backfilling by hand or by carefully dumping small quantities of fill from a loader bucket, until fill has progressed to 6 inches above the top of the pipe.

3.14 FINAL BACKFILLING

A. Final backfilling shall be performed as soon as practicable after inspection and initial backfilling is complete. Adequate precautions shall be taken to insure proper placement and compaction of backfill without disturbing or damaging pipe. Fill shall be properly compacted and suitable precautions shall be taken to insure permanent stability for pipe. Utilities shall be provided with adequate cover or additional protection as described in this Section.

B. Backfill - General:
   1. Place and compact backfill per geotechnical report in excavations promptly, but not before completing the following:
      a. Do not place on subgrade that contains frost, mud or is frozen.
      b. Construction below finish grade including, where applicable, damp proofing, waterproofing, and perimeter insulation.
      c. Surveying locations of underground utilities for record documents.
      d. Inspecting and testing underground utilities.
      e. Removing concrete formwork.
      f. Removing trash and debris.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

g. Removing temporary shoring and bracing, and sheeting.
h. Installing permanent or temporary horizontal bracing on horizontally supported walls.

C. Backfilling in unimproved areas:
1. Dispose of all soft, yielding or organic material that is unsuitable for trench backfill and replace with suitable material. The maximum dimension of individual stones and broken rock within the backfill should not exceed 6 inches.
2. Deposit, spread and compact backfill in even layers no greater than 12 inches deep to the surface with suitable equipment in such a manner so as not to disturb the pipe. If earth material for backfill is, in the opinion of the Engineer or his representative, too dry to allow thorough compaction, the Contractor shall add enough water so that the backfill can be properly compacted.
3. Neatly round sufficient surplus excavated material over the trench to compensate for settlement of the backfill.
4. The top 12 inches of backfill material shall consist of fine loose earth free from large clods, vegetable matter, debris, stone and/or other objectionable materials.
5. Properly dispose of all excess excavated material.
6. Prior to final acceptance, finish grade, restore topsoil and reestablish landscaping as specified.

D. Backfilling beneath flexible and rigid pavements:
1. Use Class I angular material of either crushed limestone or crushed gravel of high weight and density.
2. Carefully deposit in uniform layers, not to exceed 6 inches thick.
3. Compact each layer thoroughly by rolling, ramming and tamping with tools suitable for that purpose in such a manner so as not to disturb the pipe.
4. Flowable fill may be used at the Contractor’s request with approval of the Engineer, when specified on a particular project.

E. Backfilling of shoulders along streets and highways:
1. Backfilling methods and materials for shoulders along streets and highways shall be in accordance with the requirements of governing State, County or City departments maintaining the particular roadway or highway.
2. Replace with similar materials, all shoulders that may be damaged or destroyed as a result of pipe trenching.
3. Backfilling of shoulders shall not be directly measured for payment.
4. Where shoulders along state highways have seal coat surfaces, replace with double bituminous seal in accordance with KYTC requirements.
5. Where KYTC or local authority requires trenches to be backfilled entirely with granular material in the shoulder of roads, granular material so placed shall not be a pay item, but included in the prices per linear foot of pipe unless provided for specifically on the Bid Form.
6. Backfill in state highways may also be performed utilizing flowable fill. Refer to Division 32 Section "Asphalt Paving," for installation requirements.

F. Crushed stone for pavement and shoulder replacement:
1. Where possible, salvage and reuse all base material that is removed during construction.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2. Wet and thoroughly compact crushed stone and blade to tie into the existing surface prior to final acceptance.
3. Base material placed as a portion of pavement replacing items will not be measured for payment.

G. Compact backfill to provide 95 percent of the maximum density as measured by Standard Proctor ASTM D698.

3.15 ANTI-SEEP COLLAR

A. Anti-seep collars shall be installed in the bedding and backfill of new or replaced gravity sewer lines to limit the drainage area subject to the French drain effect of gravel bedding.

B. Anti-seep collars shall consist of compacted clay bedding and backfill at least three (3) feet thick to the top of the trench and cut into the walls of the trench two (2) feet. Alternatively, concrete may be used, keyed into the trench walls.

C. Collar material within one foot of the sewer main shall be carefully hand placed and compacted. No gravel backfill or bedding shall be used in the collar area.

D. Anti-seep collars shall be installed upstream of each manhole.

E. All stream crossings shall include collars on both sides of the crossing.

3.16 PRE-CONSTRUCTION PHOTOGRAPHS

A. The Contractor shall use the photographs and/or video taken prior to construction to aid in cleanup and restoring landscaping and other features, public or private, to their original condition or better.

3.17 FINISH GRADING AND TOPSOIL RESTORATION

A. After allowing backfill adequate time to settle, finish grade all areas to produce a uniform, satisfactory finish with rounded surfaces at the top and bottom of abrupt changes in grade.

B. Refill areas where noticeable settlement has occurred.

C. Finish grading shall be performed such that the area will drain satisfactorily and will not hold or collect standing water.

D. Restore topsoil as specified in Division 32.

E. Dress for final inspection such that the surface is free of large clods, debris, stone and/or other objectionable material.

F. Restore lawn and grass landscaping in accordance with Division 32. Final stabilization by lawn and grass landscaping shall occur within 14 days of completion of finish grading to begin establishment of ground cover to prevent erosion.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3.18 PAVEMENT MAINTENANCE AND REPLACEMENT

A. All excavation in traffic areas, whether bituminous, concrete, or gravel, shall be backfilled with compacted crushed stone. The stone shall be brought to the grade of the surrounding pavement to provide a temporary surface for traffic. The Contractor is responsible for grading and maintaining the gravel surface until the final pavement is in place.

B. Throughout the duration of the project, pavements shall be kept free of mud, gravel and other construction debris to avoid unnecessary tracking of mud and spreading of dust. If conditions warrant, the Contractor shall be responsible for arranging for street washing to remove unnecessary amounts of mud from the pavement and also to control dust. This will not be a pay item but will be a responsibility of the Contractor when conditions warrant.

C. Damaged pavement, whether concrete or asphalt, shall be properly replaced with the corresponding same equal material. The Contractor shall assume the total responsibility for repaving unless stated specifically otherwise in the Contract Documents. Pavement repair shall be in accordance with Division 32 Section "Asphalt Paving".

3.19 CURBS, SIDEWALKS, STEPS, ETC.

A. All curbs, sidewalks, steps, etc. which are damaged or disturbed shall be replaced by squarely cutting or removing at the nearest sound joint or section and re-pouring the new structure to match or exceed the quality and appearance of the original.

B. All repairs shall be compliant with BGMU and the Americans with Disabilities Act (ADA). Any new curbs, sidewalks, steps, etc shall be designed and installed to meet requirements of the ADA.

3.20 FENCES

A. All fences and posts, which are damaged or removed, shall be re-erected. Posts shall be firmly set and tamped. Wire fences shall be tightly stretched. New materials shall be used when it is obvious that the existing material cannot be reinstalled to its condition prior to being disturbed.

3.21 EROSION AND SEDIMENT CONTROL

A. The Contractor shall maintain all areas where excavating and backfilling operations are being performed or have been performed in order that siltation and bank erosion will be kept to a minimum during construction. This requirement includes construction of temporary erosion barriers and use of special methods to control erosion.

B. The Contractor shall be responsible for removing all temporary erosion protection and sediment control devices, including silt fences and check dams, after the permanent cover is established.

3.22 MAINTENANCE

A. Seed and maintain in good condition all excavated areas, trenches, fills, embankments, and channels until final acceptance by the Owner.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Maintain trench backfill at the approximate level of the original ground surface by periodically adding backfill material wherever necessary and whenever directed to do so by the Owner. Continue such maintenance until final acceptance of the project or until the Owner issues a written release.

3.23 SLOPES

A. Neatly trim all open cut slopes, and finish to conform either to the slope lines shown on the drawings or the directions of the Owner. Leave the finished surfaces of bottom and sides in reasonably smooth and uniform planes like those normally obtainable with hand tools, though the Contractor will not be required to use hand methods if he is able to obtain the required degree of evenness with mechanical equipment. Conduct grading operations so that material is not removed or loosened beyond the required slope.

3.24 FIELD QUALITY CONTROL

A. Testing Agency: Contractor will engage a qualified independent geotechnical engineering testing agency, acceptable to the Owner, to perform field quality-control testing.

B. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earthwork only after test results for previously completed work comply with requirements.

C. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design-bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by the Engineer.

D. Testing Agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable. Tests will be performed at the following locations and frequencies:
   1. Building Slab Areas: At subgrade and at each compacted fill type and backfill layer, at least one test for every 2000 sq. ft.(186 sq. m) or less building slab, but in no case fewer than three tests.
   2. Foundation Wall Backfill: At each compacted backfill layer, at least one test for each 100 feet (30 m) or less of wall length, but no fewer than two tests.
   3. Obtain samples of each type of fill from the borrow site.
   4. Determine particle size, liquid limit, plastic limit, plasticity index and maximum density of each type of soil.
   5. Observe proof rolling.
   6. Verify foundation bearing capacity.
   7. Verify quantities of material removed and quantities of material placed where Unit Prices are involved.

E. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil to depth required; recompact and retest until specified compaction is obtained.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This work shall consist of erosion control on all cut and fill operations, excavation, backfill, or other construction activities within the limits of the construction site, within any temporary or permanent easements, and within any borrow site used during the period of construction. The protection of these sites shall continue throughout the construction period.

B. During flood seasons, protect the sites by sandbagging, pumping of water, and any other means appropriate to restrain flooding. During dry weather, sprinkle the sites with water or use other means as necessary to provide dust control. In case of abnormally cold weather, any construction such as excavation work may be delayed until warmer weather or covered to prevent freezing.

C. Either permanent stabilization or temporary seeding and mulching shall occur as soon as practical after final grade is achieved, but under no circumstances shall disturbed ground be exposed for longer than 14 days.

D. The Contractor shall continuously maintain temporary erosion prevention and sediment control measures until permanent stabilization is established. The temporary pollution control provisions contained herein shall be coordinated with the permanent erosion control features, to ensure economical, effective, and continuous erosion control throughout the construction and post-construction period.

E. All erosion prevention and sediment control work shall be in compliance with the Kentucky Department of Environment and Conservation Erosion and Sediment Control Handbook. All projects shall comply with the State of Kentucky's Construction General Permit.

1.3 QUALITY ASSURANCE

A. All erosion and sediment control work shall comply with applicable requirements of governing authorities having jurisdiction. The specifications and drawings are not represented as being comprehensive, but rather convey the intent to provide complete slope protection and erosion control for both the Owner's and adjacent property.

B. Erosion control measures shall be established at the beginning of construction and maintained during the entire period of construction. On-site areas, which are subject to erosion, and off-site areas which are especially vulnerable to damage from erosion and/or sedimentation, are to be identified and receive special attention.

C. All land-disturbing activities are to be planned and conducted to minimize the size of the area to be exposed at any one time, and the length of time of exposure.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

D. Surface water runoff originating upgrade of exposed areas shall be controlled to reduce erosion and sediment loss during the period of exposure.

E. When the increase in the peak rates and velocity of storm water runoff resulting from a land-disturbing activity is sufficient to cause accelerated erosion of the receiving stream, provide measures to control both the velocity and rate of release so as to minimize accelerated erosion and increased sedimentation of the stream.

F. All land-disturbing activities shall be planned and conducted so as to minimize off-site sedimentation discharge and damage.

G. The Contractor is responsible for cleaning out and disposing of all sediment once the storage capacity of the sediment facility is reduced by one-half.

H. Frequent inspections of erosion and sediment control measures by the Contractor are required. Repair or replacement shall be made promptly.

PART 2 - PRODUCTS

2.1 TEMPORARY BERMS

A. A temporary berm is constructed of compacted soil, with or without a shallow ditch, at the top of fill slopes or transverse to centerline on fills.

B. These berms are used temporarily at the top of newly constructed slopes to prevent excessive erosion until permanent controls are installed or slopes stabilized.

2.2 TEMPORARY SLOPE DRAINS

A. Temporary slope drain is a facility consisting of stone gutters, fiber mats, plastic sheets, concrete or asphalt gutters, half round pipe, metal pipe, plastic pipe, sod, or other material that may be used to carry water down slopes to reduce erosion.

2.3 SEDIMENT STRUCTURES

A. Sediment basins, ponds, dewatering structures and traps are prepared storage areas constructed to trap and store sediment from erodible areas in order to protect properties and stream channels below the construction areas from excessive siltation.

2.4 CHECK DAMS

A. Check dams are barriers composed of large stones, sand bags, or other non-erodible materials placed across or partially crossing a natural or constructed drain way.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2.5 TEMPORARY SEEDING AND MULCHING

A. Temporary seeding and mulching are measures consisting of seeding, mulching, fertilizing, and matting utilized to reduce erosion. Seeding shall follow requirements listed in Division 32.

B. All cut and fill slopes including waste sites and borrow pits shall be seeded when and where necessary to eliminate erosion.

C. Either permanent stabilization or temporary seeding and mulching shall occur as soon as practical after final grade is achieved, but under no circumstances shall disturbed ground be exposed for longer than 14 days.

2.6 BALED HAY OR STRAW CHECKS

A. Baled hay or straw checks are temporary measures to control and prevent erosion.

B. If approved, baled hay or straw checks may be used where existing ground slopes toward or away from the embankment and shall follow the contour along the toe of slopes, in ditches, or other areas where siltation erosion or water runoff is a problem.

C. Baled hay or straw checks can only be used in conjunction with silt fence or other approved methods as temporary control measures.

2.7 TEMPORARY SILT FENCES

A. Silt fences are temporary measures utilizing woven wire or other approved material attached to posts with filter cloth composed of burlap, plastic filter fabric, etc., attached to the upstream side of the fence to retain the suspended silt particles in the runoff water.

2.8 EROSION CONTROL BLANKET/MATTING

A. Blanket and matting materials shall be non-toxic to vegetation. Netting shall be photodegradable and intertwined with mulch/fiber material. Mulch and fiber materials shall consist of straw, excelsior (curled wood), coconut, or jute (woven root fiber).

2.9 POLYMER (P.A.M.) FOR SEDIMENT CONTROL

A. Polyacrylamide (P.A.M.) is a liner polymer that electronically binds soil together to provide superior stabilization. When spread on bare ground, P.A.M. reduces and prevents moving of fine soil particles and colloidal clays with runoff water. P.A.M. also works as a trackifier. Adding P.A.M. in hydromulch mixes will increase the effectiveness of hydro seeding. Available in 50 pound bags; application rate is 10 pounds per acre.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 3 - EXECUTION

3.1 PROTECTION

A. Conduct construction so as to provide the site with maximum protection from erosion at all times.

B. Conduct excavation activities to provide erosion and sediment control as follows:
   1. Do not start clearing and excavating until a firm construction schedule is submitted to and approved by the Engineer. Continuously coordinate the schedule with the clearing and excavation activities.
   2. Place the excavated material so as not to block any drainage area. Replace this excavated material in the trench immediately after repairs or installations have been completed and are approved by the Owner.
   3. Retain natural vegetation whenever feasible.
   4. Restore and cover exposed areas subject to erosion as quickly as possible by means of seeding and mulching. Use diversion ditches or other methods as appropriate to prevent storm water from running over the exposed area until seeding is established as specified in Division 32.
   5. Take particular care along streams and drainage ditches so that fallen trees, debris, and excavated material will not adversely affect the streamflow. Exercise care to minimize the destruction of streambanks. Wherever the streambanks are affected by construction, reduce the slope of the streambanks to provide a suitable condition for vegetative protection. Minimize land exposure in terms of area and time.
   6. Cover exposed excavated areas with mulch or vegetation.
   7. Mechanically retard the rate of runoff water.
   8. Trap the sediment contained in the runoff water.
   9. Divert water from erosive areas.
   10. Take care during the hauling of materials, etc., to keep vehicles from creating an erosion problem. Proper scheduling of operations and prompt repair of ruts created during this operation is necessary from this source.
   11. Control dust by sprinkling or other means as necessary to keep it to a minimum.
   12. Stabilize roadways and driveways as soon as feasible.

C. Regrade and reseed surfaces eroded or otherwise damaged during any and all construction operations.

3.2 CONSTRUCTION REQUIREMENTS

A. The Engineer has the authority to limit the surface area of erodible earth material exposed by clearing and grubbing, the surface of erodible earth material exposed by excavation, borrow and fill operations, and to require the Contractor to provide immediate permanent or temporary pollution control measures to prevent contamination of adjacent streams or other watercourses, lakes, ponds, or other water impoundment. Such work may involve the construction of temporary berms, dikes, dams, sediment basins, slope drains, and use of temporary mulches, blanket/matting, seeding or other control devices or methods as necessary to control erosion. Cut and fill shall be seeded and mulched as the excavation proceeds to the extent required by the Engineer. Under no conditions shall the erodible earth material exposed at one time by clearing and grubbing exceed 5,000 linear feet for utility line work or one (1) acre without approval of the Engineer.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. The Contractor shall be required to incorporate all permanent erosion control features into the project at the earliest practicable time as outlined in his accepted schedule. Temporary pollution control measures not associated with permanent control features shall be used to correct conditions that develop during construction that were not foreseen during the pre-construction stage, prior to the installation of permanent pollution control features, or as needed to temporarily control erosion during normal construction practices.

C. Where erosion is likely to be a problem, clearing and grubbing operations should be so scheduled and performed that grading operations and permanent erosion control features can follow immediately thereafter if the project conditions permit; otherwise erosion control measures may be required between successive construction stages.

D. The Engineer will limit the area of excavation, borrow, and embankment operations in progress commensurate with the Contractor's capability and progress in keeping the finish grading, mulching, seeding, and other such permanent pollution control measures current in accordance with the accepted schedule. Should seasonal limitations make such coordination unrealistic, temporary erosion control measures shall be taken immediately to the extent feasible and justified.

E. Either permanent stabilization or temporary seeding and mulching shall occur as soon as practical after final grade is achieved, but under no circumstances shall disturbed ground be exposed for longer than 14 days.

F. In the event of conflict between these requirements and pollution control laws, rules or regulations, or other Federal, State or Local agencies, the more restrictive laws, rules, or regulations shall apply.

3.3 CONSTRUCTION OF STRUCTURES

A. Temporary Berms:
   1. A temporary berm shall be constructed on compacted soil, with a minimum width of 24 inches at the top and a minimum height of 12 inches, with or without a shallow ditch, constructed at the top of fill slopes or transverse to centerline on fills.
   2. Temporary berms shall be graded so as to drain to a compacted outlet at a slope drain. The area adjacent to the temporary berm in the vicinity of the slope drain must be properly graded to enable this inlet to function efficiently and with only minimum ponding in this area.
   3. All transverse berms required on the downstream side of a slope drain shall extend across the grade to the highest point at approximately a 10 degree angle with a perpendicular to centerline. The top width of these berms may be wider and the side slope flatter on transverse berms to allow equipment to pass over these berms with minimal disruptions.
   4. When practical and until final roadway elevations are approached, embankments should be constructed with a gradual slope to one side of the embankment to permit the placement of temporary berms and slope drains on only one side of the embankment.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Temporary Slope Drains
   1. Temporary slope drains shall consist of stone gutters, fiber mats, plastic sheets, concrete or asphalt gutters, half round pipe, metal pipe, plastic pipe, flexible rubber, or other materials which can be used as temporary measures to carry water accumulating in the cuts and on fills down the slopes prior to installation of permanent facilities or growth of adequate ground cover on the slopes.
   2. Fiber matting and plastic sheeting shall not be used on slopes steeper than 4:1 except for short distances of 20 feet or less.
   3. All temporary slope drains shall be adequately anchored to the slope to prevent disruption by the force of the water flowing in the drains. The base for temporary slope drains shall be compacted and formed to create a concave channel for the water or to hold the slope drain in place. The inlet end shall be properly constructed to channel water into the temporary slope drain. Energy dissipated will be accomplished at the discharge point using riprap or a small sediment basin which would slow the water as well as pick up some sediment. All temporary slope drains shall be removed when no longer necessary and the site restored to match the surroundings.

C. Sediment Structures
   1. Sediment structures shall be utilized to control sediment at the foot of embankments where slope drains outlet; at the bottom as well as in the ditch lines atop waste sites; and in the ditch lines of borrow pits. Sediment structures may be used in most drainage situations to prevent excessive siltation of pipe structures. All sediment structures shall be at least four times as long as they are wide.
   2. Dewatering structures shall be used to remove sediment from water pumped during dewatering operations. The dewatering structure must be sized to allow pumped water to flow through the filtering device without overtopping the structure. Portable sediment tanks, straw bale/silt fence pits and sediment filter bags are types of dewatering structures recommended.
   3. When use of temporary sediment structures is to be discontinued, all sediment accumulation shall be removed, and all excavation backfilled and properly compacted. The existing ground shall be restored to its natural and intended condition.

D. Check Dams
   1. Check dams shall be utilized to reduce the velocity of storm water in areas of concentrated flow, and to capture larger soil particles. Materials utilized to construct check dams are varied and should be clearly illustrated or explained in the Contractor's erosion control plan.
   2. All check dams shall be keyed into the sides and bottom of the channel. A geotextile shall be set into soil to separate soil and rock.
   3. The center of check dams should be at least 9-inches lower than either edge.
   4. Check dam structures shall be designed and installed to prevent flooding of adjacent property, buildings and residences.

E. Temporary Seeding and Mulching: Seeding and mulching shall be performed in accordance with Division 32. Seeding and mulching shall occur as soon as practical after final grade is achieved, but no later than 14 working days.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

F. Baled Hay or Straw Erosion Checks
   1. Hay or straw erosion checks shall be embedded in the ground four to six inches to prevent water flowing under them. The bales shall be installed turned upon the side of the bale with ends of adjacent bales tightly abutting one another. Each bale shall also be anchored securely to the ground with at least two wooden stakes driven through the bales into the ground. Bales can remain in place until they rot, or be removed after they have served their purpose, as determined by the Engineer. The Contractor shall keep the checks in good condition by replacing broken or damaged bales immediately after damage occurs. Normal debris cleanout will be considered routine maintenance.
   2. Baled hay or straw checks can only be used in conjunction with silt fence or other approved methods as temporary control measures.

G. Temporary Silt Fences
   1. Temporary silt fences shall be placed on the natural ground, at the bottom of fill or cut slopes, below soil stockpiles, or other areas where siltation is a problem. Silt fences are constructed of wire mesh fence with a covering of burlap or some other suitable material on the upper grade side of the fence and anchored into the soil. Temporary silt fence serves small drainage areas (maximum 1/4 acre per 100 feet of silt fence length).
   2. The Contractor shall be required to maintain the silt fence in a satisfactory condition for the duration of the project or until its removal is requested by the Engineer. The silt accumulation at the fence may be left in place and seeded or removed, as required by the Engineer. The silt fence remains the property of the Contractor whenever the fence is removed.
   3. Silt fences should not be installed across streams, ditches, waterways, or other concentrated flows. All silt fences should be installed along the contour, never up or down a slope. The bottom 6 inches of the silt fence must be entrenched and backfilled to be effective.

3.4 EROSION CONTROL BLANKET/MATTING

A. Seed and fertilizer (if required) shall be applied before installation of a blanket or mat.

B. Follow manufacturer's directions for orienting, overlapping, entrenching, and securing blankets and mats. Generally, orient blanket and mat rolls vertically along a slope, from top to bottom. Horizontal orientation is allowable only for slopes with steepness less than 2:1 and a height of less than twice the roll width.

3.5 EROSION CONTROL BLANKET/MATTING

A. Seed and fertilizer (if required) shall be applied before installation of a blanket or mat.

B. Follow manufacturer's directions for orienting, overlapping, entrenching, and securing blankets and mats. Generally, orient blanket and mat rolls vertically along a slope, from top to bottom. Horizontal orientation is allowable only for slopes with steepness less than 2:1 and a height of less than twice the roll width.

C. Always entrench the blanket or mat a minimum of 6 inches at any joint, any structure, and at the top and bottom of a slope.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3.6 DUST CONTROL

A. Dust generated during performance of the work shall be controlled by applying either water or calcium chloride.

B. Water and calcium chloride shall be provided in the amounts and locations in accordance with general local practice.

3.7 MAINTENANCE AND REMOVAL

A. The temporary erosion prevention and sediment control features installed by the Contractor shall be satisfactorily maintained by the Contractor until no longer needed or permanent erosion control methods are installed. The Contractor shall be responsible for removing silt fences and check dams after the permanent cover is established. Any materials removed shall become the property of the Contractor.

3.8 EROSION CONTROL OUTSIDE PROJECT AREA

A. Temporary erosion prevention and sediment control shall include construction work outside the Project area where such work is necessary as a result of construction, such as borrow pit operations, haul roads, and equipment storage sites.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 GENERAL

A. This work shall consist of constructing micropiles as shown on the contract plans and approved working drawings and as specified herein.

B. The micropile specialty Contractor is responsible for furnishing of all materials, products, accessories, tools, equipment, services, transportation, labor and supervision, and manufacturing techniques required for installation and testing of micropiles and pile top attachments for this project.

1.3 TOLERANCE

A. **Horizontal:** The bracing system shall act as a template for the micropiles.

B. **Vertical:** The top of piles shall be no more than 2 inches from designed top of pile elevation.

C. **Alignment:** The piles shall be installed no more than 2 degrees from the designed alignment.

1.4 EQUIPMENT

A. The equipment and accessories shall be capable of safely, and efficiently installing piles to the design requirements for the project.

B. Sufficient units of equipment must be provided to keep the agreed schedule.

1.5 SUBMITTALS

A. The Contractor shall prepare and submit to the Engineer, for review, five (5) copies of the following:
   1. Detailed step by step description of the proposed micropile construction procedure, including personnel, testing, and equipment to assure quality control.
   2. Proposed start date and time schedule.
   3. If welding of casing is proposed, submit the proposed welding procedure, certified by a qualified welding specialist.
   4. Plan describing how drill flush and excess grout will be controlled and disposed of.
   5. Coupon test results, or certified mill test reports for all permanent casing.
   6. Calibration reports and data for each test jack. The calibration test shall have been performed by an independent testing laboratory within three (3) months of the start of work.
   7. Proposed Grouting Plan. The grouting plan shall include complete descriptions and details for the following:
      a. Grout mix design.

b. Methods and equipment for monitoring and recording the grout volume.
c. Procedure and equipment for Contractor monitoring of grout quality.

B. Work other than test pile installation shall not begin until the construction submittals have been received, reviewed, and accepted in writing by the Engineer. The Contractor shall allow seven (7) calendar days to review the construction submittals after a complete set has been received. Costs associated with incomplete or unacceptable Contractor submittals shall be the responsibility of the Contractor.

1.6 SCOPE OF WORK

A. The scope of work includes all labor, material and equipment necessary to sufficiently complete the following work:
1. Supply and install the micropile foundation as shown on the plans.
2. Trim the piles to the designed elevation.
3. Perform one sacrificial load test as specified.

PART 2 - PRODUCTS

2.1 MATERIALS

A. **Admixtures for Grout:** Admixtures shall conform to the requirements of ASTM C 494/AASHTO M194. Admixtures that control bleed, reduce water content, and retard set may be used in the grout, subject to the review and acceptance of the Engineer. Admixtures shall be compatible with the grout and mixed in accordance with the manufacturer's recommendations. Admixtures containing chlorides are not permitted.

B. **Cement:** All cement shall be Portland cement and shall conform to ASTM C150, Types II or III.

C. **Centralizers and Spacers:** Centralizers shall be constructed of material that is non-deleterious to the grout or reinforcement. Wood is specifically prohibited. Centralizers shall be securely attached to the reinforcement and sized to position the reinforcement within ½ inch of plan location. Centralizers shall not impede the flow of grout or the placement of the reinforcement.

D. **Grout:** Grout shall be neat cement grout with a minimum unconfined compressive strength of 4,000 psi at 28 days. Micropiles shall be grouted from the bottom up using the tremie method until clean grout is returned to the surface.

E. **Casing:** Casing shall conform to ASTM A252, except with a minimum yield strength of 80 ksi. Casing may be new "Structural Grade" (A.K.A. "Mill Secondary") steel pipe meeting ASTM A252 but without mill certifications, free from defect (dents, cracks, tears) and with at least one coupon test per truck load delivered to the fabricator.

F. **All Thread Reinforcement:** Reinforcement shall conform to ASTM A615 grade 60 ksi.

G. **Bearing Plates:** Bearing plates shall be fabricated from steel that conforms to ASTM A572 grade 50 ksi.

H. **Water:** Water used in the grout mix shall conform to AASHTO T26 and shall be potable, clean, and free from substances that may be deleterious to the grout or pile steel.

2.2 CONSTRUCTION REQUIREMENTS

A. The Contractor shall control and properly dispose of drilling flush and excess grout, and related waste, in accordance with all applicable local codes and regulations.

B. Prior to drilling Contractor shall locate all existing utilities. If utilities interfere with the proposed work contact the Engineer.

C. If threaded casing is used, the Contractor shall ensure that no casing joints are within the length starting from 1'-6" above the bottom of the bracing system to 10'-0" below the mud line. If this is not possible with the Contractor's equipment, full moment couplers or an internal 5.5-inch x 0.5-inch casing (5'-0" long, centered on the joint) must be used for any joints within this length.

PART 3 - EXECUTION

3.1 MICROPILE INSTALLATION

A. **Drilling:** The Contractor shall select the drilling method, and the grouting method used for the installation of the micropiles. The drilling equipment and methods shall be suitable for the conditions to be encountered during drilling, without causing damage to any overlying or adjacent structures or utilities. The drilling method must ensure a clean hole and open holes. Care should be taken to ensure that a clean surface is maintained in the bond zone for proper bonding of the pile to competent bedrock. The Contractor's proposed method(s) to provide drill-hole support and to prevent detrimental ground movements shall be reviewed by the Engineer. Detrimental ground movement is defined as movement which requires remedial repair measures. Use of drilling fluid that contains bentonite is not allowed.

B. **Grouting:** Micropiles shall be grouted the same day the load transfer bond length is drilled. The grouting equipment used shall produce a grout free of lumps and un-dispersed cement. The grouting equipment shall be sized to ensure that a pile can be grouted in one continuous operation. The grout shall be placed using the tremie method from the bottom of the piles, until clean grout flows from the top of the pile. Upon completion of the grouting the grout tube may remain in the hole, however it must be filled with grout.

C. **Installation Records:** Contractor shall prepare and submit to the Engineer full-length records for each micropile installed. The records shall be submitted within one work shift after that pile installation is completed. Grout logs shall contain the following:

1. Reference number of pile
2. Drill date
3. Grout date
4. Total drill length
5. Total bond length
6. Description of drilled materials (note any obstruction or voids)

7. Grout take
8. Length and size of casing used
9. Length and size of reinforcement used.

D. **Grout Tests:** Contractor shall cast a minimum of one set of six (6) 2-inch cubes or one set of six (6) 3-inch x 6-inch cylinders daily. Of these samples one shall be tested for unconfined compressive strength as follows: one at 3 days, one at 7 days, and one at 28 days, the remaining samples may be discarded once adequate grout strength has been satisfied for that set of samples. In addition, the Contractor shall test the unit weight of the grout prior to placement in the micropiles, by means of a "mud cup".

3.2 MICROPILE LOAD TEST

A. Contractor shall perform one (1) sacrificial load test in accordance with the applicable ASTM standard prior to construction of production piles. Contractor may proceed with the construction of the production micropiles provided that it is at his risk. At the Contractor's option, either an axial compression test (ASTM D1143) or axial tension test (ASTM D3689) may be performed provided that the applied test load is equal to two (2) times the design load. The "Quick Load Test Method for Individual Piles" is acceptable. The design load of the micropiles is 290 kips.

3.3 MICROPILE LOAD TEST ACCEPTANCE CRITERIA

A. The micropile load test shall be considered acceptable if the results meet the following criteria:
   a. Failure does not occur at any load increment up to and including two (2) times the design load. Failure is defined as the load at which attempts to further increase the test load results in continued pile movement without increase in applied load.
   b. Creep is less than 0.040 inches from 1 minute to 10 minutes or less than 0.080 inches from 6 to 60 minutes.
   c. The total deflection at two (2) times the design load is less than the elastic deflection of the free length plus the bond length.

3.4 MICROPILE LOAD TEST LOADING SCHEDULE

A. The load test shall be performed by incrementally increasing the load in accordance with the following table:

Load Test Loading Schedule	
AL = Alignment Load, DL = Design Load	
Load	Hold Time
AL (5% DL Max.)	1 Minute
10% DL	1 Minute
20% DL	1 Minute
30% DL	1 Minute
40% DL	1 Minute
50% DL	1 Minute
60% DL	1 Minute

70% DL	1 Minute
80% DL	1 Minute
90% DL	1 Minute
100% DL	1 Minute
110% DL	1 Minute
120% DL	1 Minute
130% DL	1 Minute
140% DL	1 Minute
150% DL	1 Minute
160% DL	1 Minute
170% DL	1 Minute
180% DL	1 Minute
190% DL	1 Minute
200% DL	10 - 60 Minutes (Hold for Creep)
150% DL	1 Minute
100% DL	1 Minute
50% DL	1 Minute
0% DL	1 Minute

B. Pile movements during the creep test shall be measured and recorded at 1, 2, 3, 4, 5, 6, 10, 20, 30, 50 and 60 minutes. If the creep from 1 minute to 10 minutes is greater than 0.040 inches the test shall be held for an additional 50 minutes.

3.5 BASIS OF PAYMENT

A. The quantities accepted for payment will be paid for at the contract unit prices for the items listed below, complete in place and accepted, which price shall include all materials, equipment, tools, proper disposal of drilling spoil, and labor incidental thereto.

Pay Item	Pay Unit	Quantity	Notes
Micropiles	Lump Sum	1	
Load Test	EA.	1	
Micropiles Length Add	L.F.		
Micropiles Length Deduction	L.F.		

END OF SECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes threaded bar rock anchor assemblies.

B. Refer to Division 01 Section "Measurement and Payment" for description of Work in this Section affected by unit prices.

1.3 REFERENCES

A. The following is a list of standards which may be referenced in this section:
   1. ASTM International (ASTM):
      a. A615, Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
      b. A706, Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
      c. A722, Standard Specification for Uncoated high-Strength Steel Bar for Prestressing Concrete.
      d. C33, Standard Specification for Concrete Aggregates
      e. C150, Standard Specification for Portland Cement.
      f. C940, Standard Test Method for Expansion and Bleeding of Freshly Mixed Grouts for Pre-placed-Aggregate Concrete in the Laboratory.
      g. C1107, Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
      h. D4435, Standard Method for Rock Bolt Anchor Pull Test.
   2. U.S. Army Corps of Engineers (COE):
      a. CRD-C611, Test Method for Flow of Grout Mixtures (Flow Cone Method).
      b. CRD-C621, Corps of Engineers Specification for Nonshrink Grout.

1.4 SUBMITTALS

A. Action Submittals:
   1. Placing drawings.
   2. Bar details.
   3. Manufacturer's data, recommendations, and instructions for project specific use for following products:
      a. Bars.
      b. Couplers/splices.
      c. Grout.

B. Informational Submittals:
   1. Test data for couplers/splices.

2. Laboratory test reports for anchor bars showing stress-strain curves and ultimate strengths.
3. Grout test results.
4. Volumes of grout take for each grouting of each anchor hole.
5. Pullout test results.
6. Calibration data for pullout test load measurement system.
7. Record drawings showing final location, elevation, and depth of each anchor bar hole.

PART 2 - PRODUCTS

2.1 THREAD BARS

A. Conform to ASTM A722.

B. Furnish with couplers as required for complete installation:
1. Screw-on type, as furnished by thread bar manufacturer.
2. Sufficiently strong to develop 125 percent of guaranteed yield strength of bars without evidence of failure.

C. Manufacturer and Product:
1. Dywidag Systems International, USA, Inc., Lincoln Park, NJ; Dywidag Thread Bar Reinforcing System.
2. Williams Form Engineering Corp.; All-Thread-Bar.
3. Approved equal.

2.2 ANCHOR GROUT

A. Prepackaged, requiring only addition of water, and conforming to ASTM C1107, Grade B.

B. Nonmetallic and free of chlorides or other elements or compounds corrosive to steel.

C. Mixed with Water: Pumpable, nonshrink, nonbleeding, and nongas forming.
1. Time of Efflux: 20 to 30 seconds as determined in accordance with CRD-C611 when initially mixed.
2. Extended Working Time: Fluid and capable of completely passing flow cone of CRD-C611 for at least 1 hour.

D. Cube Strength: Minimum 2,500 psi at 1 day and 5,000 psi at 28 days when sampled and tested in accordance with CRD-C621.

E. Manufacturers and Products:
1. Master Builders Co., Cleveland, OH; Master Flow 928.
2. Euclid Chemical Co., Cleveland, OH; Hi-Flow Grout.
3. Approved equal.

PART 3 - EXECUTION

3.1 DRILLING

A. Anchor Locations, Elevations, Depths, and Orientation:
   1. As shown, unless adjusted by Engineer subject to conditions encountered in field.
   2. Final locations, elevations, and depths shall be within plus or minus 0.1 foot and final orientations within plus or minus 5 degrees.

B. Method:
   1. Coring, rotary drilling, or percussion-air-hammer type drilling.
   2. Use water or air with sufficient moisture for dust control to remove cuttings.
   3. Do not use rod dope, grease, or other lubricants in drilling operations.

C. Minimum Hole Diameter: Larger of the following:
   1. Hole diameter as shown.
   2. 1-1/2 times bar diameter.
   3. 1-1/2 times coupler/splice diameter.
   4. As required to accommodate grout and vent tubes with bar centered in hole.

3.2 HOLE PREPARATION FOR ANCHOR INSTALLATION AND GROUTING

A. If water or caving conditions are encountered, fill hole with consolidation grout and drill out grout after it sets. Repeat grouting and redrilling until dry and stable hole is achieved.

B. After completion of dry and stable hole, wash sides of hole with nozzle that impinges water on sides of hole with sufficient velocity to remove loose or caked material from the hole.

C. Immediately prior to anchor installation, reflush hole with water if necessary to saturate surfaces, sound hole for compliance with required depth, and remove standing water from hole.

D. Prevent entry of unwanted grout, concrete, or debris into drilled holes until anchor installation and grouting is completed.

3.3 HOLE ABANDOMENT

A. If hole is rejected by Engineer, fill hole with grout as specified for anchor grouting.

B. Drill new hole in location determined by Engineer.

3.4 BAR PREPARATION

A. Immediately prior to installation, remove dirt, grease, loose rust, or other deleterious substances from bar and coupler/splice surfaces and check passages through hollow bars, if used, with air or water to ensure that they are clear.

3.5 VENT AND GROUT TUBE PREPARATION

A. Immediately prior to insertion, check vent and grout tubes with air or water to ensure that they are clear.

3.6 BAR INSTALLATION

A. Install each bar prior to grouting.

B. Rigidly support each bar centered in its hole during placement of grout and until grout sets.

C. Alternatively, install bar after completely filling hole with grout, provided bar can be pushed into position without damage, and grout cannot flow out of hole by gravity.

3.7 VENT AND GROUT TUBE INSTALLATION

A. For anchors installed in holes drilled horizontally or downward, insert grout tube with its discharge end at back or bottom of hole, respectively.

B. For anchors installed in holes drilled upward, insert grout tube with its discharge end at lower end of hole, and insert vent tube with its intake end at upper end of hole.

C. Grout Tube Diameter: 1 inch, minimum.

D. Vent Tube Diameter: 1/4 inch, minimum.

E. For anchors installed in holes drilled horizontally or upward, seal hole at rock face with grout after installing vent and grout tubes. Before grouting remaining hole, allow grout seal to gain sufficient strength to resist grouting pressures and recheck vent and grout tubes with air to ensure that they are clear.

3.8 MIXING GROUT WITH WATER

A. Mix anchor grout in accordance with manufacturer's instructions.

B. Equipment used to mix grout shall be capable of achieving uniform mixture, free of lumps, within 3 minutes of time grout is added to water.

C. After each batch is initially proportioned to required consistency, do not add additional water.

D. Do not mix more grout mix than can be placed within 25 minutes.

3.9 PUMPING GROUT

A. Screen mixed grout prior to pumping through maximum 1/8 inch clear openings. Screen shall be easily accessible for inspection and cleaning.

B. Measure quantity of grout pumped within 0.1 cubic foot.

C. Pump grout at rates sufficient to fill annulus space around bar within working time of grout.

3.10 PLACING GROUT

A. For anchors installed in holes drilled horizontally or downward, inject grout at back or bottom of hole, respectively, displacing air and water out of hole.

B. For anchors installed in holes drilled upward, inject grout at lower end of hole, displacing air out of hole via vent tube.

C. If grout tube is withdrawn, keep grout tube below grout surface until hole is completely filled, and continue pumping as tube is withdrawn.

3.11 TESTING GROUT

A. Fluid Consistency:
1. Determine time of efflux in accordance with CRD-C611.
2. One test for each batch mixed.

B. Nonbleeding:
1. Determine in accordance with ASTM C940.
2. No surface bleed water present up to 4 hours.
3. One test each day of grouting.

C. Shrinkage:
1. Determine in accordance with CRD-C621.
2. One test each day of grouting.

D. Compressive Strength:
1. Determine compressive strength of grout cubes sampled and tested in accordance with CRD-C621.
2. Minimum of one test per day and whenever proportion of mix is changed.

3.12 PULLOUT TESTS

A. Test 5 percent of anchors to verify adequate pullout resistance.

B. Engineer will determine which anchors shall be tested.

C. Test anchors after grout has achieved 4,000 psi compressive strength.

D. Apply test load in tension equal to 80 percent of yield strength of bar. Maintain load for minimum of 10 minutes. If bar moves while maintaining test load, or if application of full test load is not possible, anchor will be rejected.

E. Test Apparatus: Conform to ASTM D4435 for each of following items:
1. Loading system.
2. Load transducer.

3. Displacement transducer.
4. Displacement transducer support.

F. Load measurement systems shall be calibrated by independent testing laboratory and accurate to within plus or minus 5 percent of actual load.

G. Method of load application shall not damage bar.

H. Install replacement anchors for each failed anchor at location determined by Engineer.

I. Retest one additional anchor bar for each failed bar in addition to number initially required.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Hot-mix asphalt patching/repairing.

B. Related Sections include the following:
   1. Division 31 Section "Site Excavation, Backfilling, and Compaction" for aggregate subbase and base courses and for aggregate pavement shoulders.

1.3 DEFINITIONS

A. Hot-Mix Asphalt Paving Terminology: Refer to ASTM D 8 for definitions of terms.

B. KYTC: Kentucky Transportation Cabinet.

1.4 SYSTEM DESCRIPTION

A. Provide hot-mix asphalt paving according to materials, workmanship, and other applicable requirements of standard specifications of state or local DOT.
   1. KYTC Standard Specification: Kentucky Transportation Cabinet Standard Specifications for Road and Bridge Construction.
   2. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated. Include technical data and tested physical and performance properties.

B. Job-Mix Designs: Certification, by authorities having jurisdiction, of approval of each job mix proposed for the Work.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer.
   1. Manufacturer shall be a paving-mix manufacturer registered with and approved by authorities having jurisdiction or the DOT of the state in which Project is located.

B. Regulatory Requirements: Comply with KYTC for asphalt paving work.

C. Asphalt-Paving Publication: Comply with AI MS-22, "Construction of Hot Mix Asphalt Pavements," unless more stringent requirements are indicated.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp or if the following conditions are not met:
   1. Prime and Tack Coats: Minimum surface temperature of 60 deg F(15.5 deg C).
   2. Asphalt Base Course: Minimum surface temperature of 40 deg F(4 deg C) and rising at time of placement.
   3. Asphalt Surface Course: Minimum surface temperature of 60 deg F(15.5 deg C) at time of placement.

PART 2 - PRODUCTS

2.1 AGGREGATES

A. General: Use materials and gradations that have performed satisfactorily in previous installations and complying with requirements of KYTC Standard Specification 805.

B. Coarse Aggregate: ASTM D 692, sound; angular crushed stone, crushed gravel, or properly cured, crushed blast-furnace slag.

C. Fine Aggregate: ASTM D 1073, sharp-edged natural sand or sand prepared from stone, gravel, properly cured blast-furnace slag, or combinations thereof.
   1. For hot-mix asphalt, limit natural sand to a maximum of 20 percent by weight of the total aggregate mass.

D. Mineral Filler: ASTM D 242, rock or slag dust, hydraulic cement, or other inert material.

2.2 ASPHALT MATERIALS

A. Asphalt Binder: AASHTO MP 1, PG 64-22.

B. Asphalt Cement: Material complying with requirements of KYTC Standard Specification 806.

C. Prime Coat: Asphalt emulsion prime complying with requirements of KYTC Standard Specifications.

D. Tack Coat: ASTM D 977, emulsified asphalt, slow setting, diluted in water, of suitable grade and consistency for application, complying with requirements of KYTC Standard Specification 406.

E. Water: Potable.

2.3 AUXILIARY MATERIALS

A. Sand: ASTM D 1073, Grade Nos. 2 or 3.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Joint Sealant: ASTM D 3405, hot-applied, single-component, polymer-modified bituminous sealant.

C. Glass Beads: AASHTO M 247, Type 1.

2.4 MIXES

A. Hot-Mix Asphalt: Dense, hot-laid, hot-mix asphalt plant mixes approved by authorities having jurisdiction; designed according to procedures in AI MS-2, "Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types"; and complying with the following requirements:
   1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.
   2. Bituminous Base Course: KYTC Standard Specification 401, Grading "B-M" or "B" if in R.O.W.
   3. Asphaltic Surface Course: KYTC Standard Specification 403, Grading "E".

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that subgrade is dry and in suitable condition to support paving and imposed loads.

B. Proof-roll subbase to locate areas that are unstable or that require further compaction.

C. Proceed with paving only after unsatisfactory conditions have been corrected.

3.2 PATCHING

A. Hot-Mix Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches(300 mm) into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade.

B. Tack Coat: Apply uniformly to vertical surfaces abutting or projecting into new, hot-mix asphalt paving at a rate of 0.05 to 0.15 gal./sq. yd.(0.2 to 0.7 L/sq. m).
   1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
   2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

C. Patching: Fill excavated pavements with hot-mix asphalt base mix and, while still hot, compact flush with adjacent surface.

3.3 REPAIRS

A. Leveling Course: Install and compact leveling course consisting of hot-mix asphalt surface course to level sags and fill depressions deeper than 1 inch(25 mm) in existing pavements.
   1. Install leveling wedges in compacted lifts not exceeding 3 inches(75 mm) thick.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Crack and Joint Filling: Remove existing joint filler material from cracks or joints to a depth of 1/4 inch(6 mm).
   1. Clean cracks and joints in existing hot-mix asphalt pavement.
   2. Use emulsified-asphalt slurry to seal cracks and joints less than 1/4 inch(6 mm) wide. Fill flush with surface of existing pavement and remove excess.
   3. Use hot-applied joint sealant to seal cracks and joints more than 1/4 inch(6 mm) wide. Fill flush with surface of existing pavement and remove excess.

3.4 HOT-MIX ASPHALT PLACING

A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.
   1. Place hot-mix asphalt base course in number of lifts and thicknesses indicated.
   2. Place hot-mix asphalt surface course in single lift.
   3. Spread mix at minimum temperature of 250 deg F(121 deg C).
   4. Begin applying mix along centerline of crown for crowned sections and on high side of one-way slopes, unless otherwise indicated.
   5. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.

B. Place paving in consecutive strips not less than 10 feet(3 m) wide unless infill edge strips of a lesser width are required.
   1. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Complete a section of asphalt base course before placing asphalt surface course.

C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.5 JOINTS

A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions with same texture and smoothness as other sections of hot-mix asphalt course.
   1. Clean contact surfaces and apply tack coat to joints.
   2. Offset longitudinal joints, in successive courses, a minimum of 6 inches(150 mm).
   3. Offset transverse joints, in successive courses, a minimum of 24 inches(600 mm).
   4. Construct transverse joints as described in AI MS-22, "Construction of Hot Mix Asphalt Pavements."
   5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.
   6. Compact asphalt at joints to a density within 2 percent of specified course density.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3.6 COMPACTION

A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or vibratory-plate compactors in areas inaccessible to rollers.
   1. Complete compaction before mix temperature cools to 185 deg F(85 deg C).

B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.

C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:
   1. Average Density: 92 percent of reference maximum theoretical density according to ASTM D 2041, but not less than 90 percent nor greater than 96 percent.

D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.

E. Edge Shaping: While surface is being compacted and finished, trim edges of pave-ment to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.

F. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.

G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.7 INSTALLATION TOLERANCES

A. Thickness: Compact each course to produce the thickness indicated within the following tolerances:
   1. Bituminous Base Course: Plus or minus 1/2 inch(13 mm).
   2. Asphaltic Surface Course: Plus 1/4 inch(6 mm), no minus.

B. Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot(3-m) straightedge applied transversely or longitudinally to paved areas:
   1. Bituminous Base Course: 1/4 inch(6 mm).
   2. Asphaltic Surface Course: 1/8 inch(3 mm).

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3.8 DISPOSAL

A. Except for material indicated to be recycled, remove excavated materials from Project site and legally dispose of them in an EPA-approved landfill.
   1. Do not allow excavated materials to accumulate on-site.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes exterior cement concrete pavement for the following:
   1. Driveways and roadways.
   2. Parking lots.
   3. Curbs and gutters.
   4. Walkways.

B. Related Sections include the following:
   1. Division 31 Section "Site Excavation, Backfilling, and Compaction" for subgrade preparation, grading, and subbase course.

1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, expansive hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume.

1.4 SUBMITTALS

A. Design Mixes: For each concrete pavement mix. Include alternate mix designs when characteristics of materials, project conditions, weather, test results, or other circumstances warrant adjustments.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed pavement work similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

B. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 to conduct the testing indicated, as documented according to ASTM E 548.

C. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant and each aggregate from one source.

D. ACI Publications: Comply with ACI 301, "Specification for Structural Concrete," unless modified by the requirements of the Contract Documents.

E. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1.6 PROJECT CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for facility operations and construction activities.

PART 2 - PRODUCTS

2.1 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, smooth exposed surfaces.
   1. Use flexible or curved forms for curves of a radius 100 feet(30.5 m) or less.

B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

2.2 STEEL REINFORCEMENT

A. Plain-Steel Welded Wire Fabric: ASTM A 185, fabricated from as-drawn steel wire into flat sheets.

B. Deformed-Steel Welded Wire Fabric: ASTM A 497, flat sheet.

C. Reinforcement Bars: ASTM A 615/A 615M, Grade 60(Grade 420), deformed.

D. Steel Bar Mats: ASTM A 184/A 184M; with ASTM A 615/A 615M, Grade 60 (Grade 420), deformed bars; assembled with clips.

E. Plain Steel Wire: ASTM A 82, as drawn.

F. Joint Dowel Bars: Plain steel bars, ASTM A 615/A 615M, Grade 60(Grade 420). Cut bars true to length with ends square and free of burrs.

G. Tie Bars: ASTM A 615/A 615M, Grade 60(Grade 420), deformed.

H. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcement bars, welded wire fabric, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete or fiber-reinforced concrete of greater compressive strength than concrete.

2.3 CONCRETE MATERIALS

A. General: Use the same brand and type of cementitious material from the same manufacturer throughout the Project.

B. Portland Cement: ASTM C 150, Type I or II.
   1. Fly Ash: ASTM C 618, Class F or C.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

C. Aggregate: ASTM C 33, uniformly graded, from a single source, with coarse aggregate as follows:
   1. Maximum Aggregate Size: 1-1/2 inches(38 mm) nominal.
   2. Do not use fine or coarse aggregates containing substances that cause spalling.

D. Water: ASTM C 94.

2.4 ADMIXTURES

A. General: Admixtures certified by manufacturer to contain not more than 0.1 percent water-soluble chloride ions by mass of cement and to be compatible with other admixtures.

B. Air-Entraining Admixture: ASTM C 260.

2.5 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd.(305 g/sq. m) dry.

B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

C. Water: Potable.

D. White Waterborne Membrane-Forming Curing Compound: ASTM C 309, Type 2, Class B.

E. Clear Waterborne Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B.

F. Products: Subject to compliance with requirements, provide one of the following:
   1. White Waterborne Membrane-Forming Curing Compound:
      a. AH Curing Compound #2 WB WP; Anti-Hydro International, Inc.
      b. Aqua Resin Cure; Burke Group, LLC (The).
      c. W.B. Resin Cure; Conspec Marketing & Manufacturing Co., Inc.
      d. Thinfilm 450; Kaufman Products, Inc.
      e. Aqua Kure-White; Lambert Corporation.
      f. L&M Cure R-2; L&M Construction Chemicals, Inc.
      g. 1200-White; W. R. Meadows, Inc.
      h. White Pigmented Resin Cure E; Nox-Crete Products Group, Kinsman Corporation.
      i. Resi-Chem High Cure; Symons Corporation.
      j. Horncure 200-W; Tamms Industries Co., Div. of LaPorte Construction Chemicals North America, Inc.
      k. Hydro White 309; Unitex.
   2. Clear Waterborne Membrane-Forming Curing Compound:
      a. AH Curing Compound #2 DR WB; Anti-Hydro International, Inc.
      b. Aqua Resin Cure; Burke Group, LLC (The).
      c. Safe-Cure Clear; ChemMasters.
      d. W.B. Resin Cure; Conspec Marketing & Manufacturing Co., Inc.
      e. Day Chem Rez Cure (J-11-W); Dayton Superior Corporation.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

f. Aqua Kure-Clear; Lambert Corporation.
g. L&M Cure R; L&M Construction Chemicals, Inc.
h. 1100 Clear; W. R. Meadows, Inc.
i. Resin Cure E; Nox-Crete Products Group, Kinsman Corporation.
j. Resi-Chem Clear Cure; Symons Corporation.
k. Horncure WB 30; Tamms Industries Co., Div. of LaPorte Construction Chemicals North America, Inc.
l. Hydro Cure 309; Unitex.
m. Certi-Vex Enviocure 100; Vexcon Chemicals, Inc.

2.6 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber, or ASTM D 1752, cork or self-expanding cork, or ASTM D 1752-84, recycled rubber.

B. Pavement-Marking Paint: Alkyd-resin type; lead and chromate free; ready mixed; complying with requirements of TDOT Standard Specification 910.

C. Glass Beads: AASHTO M 247.

D. Wheel Stops:
1. Precast, air-entrained concrete; 2500-psi(17.2-MPa) minimum compressive strength; approximately 6 inches(150 mm) high, 9 inches(225 mm) wide, and 84 inches(2130 mm) long. Provide chamfered corners and drainage slots on underside, and provide holes for dowel-anchoring to substrate.
2. Solid, integrally colored, 96 percent recycled HDPE or commingled postconsumer and postindustrial recycled plastic; UV stabilized; 4 inches (100 mm) high by 6 inches (150 mm) wide by 72 inches (1820) mm long. Provide chamfered corners and drainage slots on underside and holes for anchoring to substrate.
3. Dowels: Steel, diameter of 3/4 inch(19 mm).

E. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

F. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class and grade to suit requirements, and as follows:
1. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

2.7 CONCRETE MIXES

A. Prepare design mixes, proportioned according to ACI 211.1 and ACI 301, for each type and strength of normal-weight concrete determined by either laboratory trial mixes or field experience.

B. Proportion mixes to provide concrete with the following properties:
1. Minimum Compressive Strength (28 Days): 3000 psi(20.7 MPa), unless noted otherwise on the Drawings.
2. Maximum Water-Cementitious Materials Ratio: 0.45.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3. Slump Limit: 4 inches(100 mm).
   a. Slump Limit for Concrete Containing High-Range Water-Reducing Admixture: Not more than 8 inches(200 mm) after adding admixture to plant- or site-verified, 2- to 3-inch(50- to 75-mm) slump.
4. Air Content: 4-1/2 percent plus or minus 1.5 percent.

C. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
1. Fly Ash: 25 percent.
2. Combined Fly Ash and Pozzolan: 25 percent.

D. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an air content of 2.5 to 4.5 percent.

E. Synthetic Fiber: Uniformly disperse in concrete mix at manufacturer's recommended rate, but not less than 1.0 lb/cu. yd.(0.60 kg/cu. m).

2.8 CONCRETE MIXING

A. Ready-Mixed Concrete: Comply with requirements and with ASTM C 94.
1. When air temperature is between 85 deg F(30 deg C) and 90 deg F(32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F(32 deg C), reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances, including accessibility slopes and cross-slopes. Verify location of all accessible routes.

B. Proof-roll prepared subbase surface to check for unstable areas and verify need for additional compaction. Proceed with pavement only after nonconforming conditions have been corrected and subgrade is ready to receive pavement.

3.2 PREPARATION

A. Remove loose material from compacted subbase surface immediately before placing concrete.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides for pavement to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

B. Clean forms after each use and coat with form release agent to ensure separation from concrete without damage.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3.4 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating reinforcement and with recommendations in CRSI's "Placing Reinforcing Bars" for placing and supporting reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.

C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.

D. Install welded wire fabric in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

E. Install fabricated bar mats in lengths as long as practicable. Handle units to keep them flat and free of distortions. Straighten bends, kinks, and other irregularities, or replace units as required before placement. Set mats for a minimum 2-inch(50-mm) overlap to adjacent mats.

3.5 JOINTS

A. General: Construct construction, isolation, and contraction joints and tool edgings true to line with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline, unless otherwise indicated.
   1. When joining existing pavement, place transverse joints to align with previously placed joints, unless otherwise indicated.

B. Construction Joints: Set construction joints at side and end terminations of pavement and at locations where pavement operations are stopped for more than one-half hour, unless pavement terminates at isolation joints.
   1. Continue reinforcement across construction joints, unless otherwise indicated. Do not continue reinforcement through sides of pavement strips, unless otherwise indicated.
   2. Provide tie bars at sides of pavement strips where indicated.
   3. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

C. Expansion Joints: Form expansion joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, walks, other fixed objects, and where indicated.
   1. Locate expansion joints at intervals of 50 feet(15.25 m) for each pavement lane and curbs, unless otherwise indicated. Locate expansion joints at maximum 30 feet o.c. for sidewalks. Locate expansion joints at all curb returns.
   2. Extend joint fillers full width and depth of joint.
   3. Terminate joint filler not less than 1/2 inch(12 mm) or more than 1 inch(25 mm) below finished surface if joint sealant is indicated.
   4. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

5. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
6. Protect top edge of joint filler during concrete placement with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.

D. Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt-coat one-half of dowel length to prevent concrete bonding to one side of joint.

E. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as follows: In vehicular pavements, place contraction joints to form squares and to not exceed 12 feet on any side. In sidewalks, place contraction joints to form squares and to not exceed 6 feet on any side. In curbs, place contraction joints at 10 feet on center. See drawings for additional information.

F. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows:
1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with groover tool to the following radius. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover marks on concrete surfaces.
   a. Radius: 1/4 inch(6 mm).
2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch-(3-mm-) wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.

G. Edging: Tool edges of pavement, gutters, curbs, and joints in concrete after initial floating with an edging tool to the following radius. Repeat tooling of edges after applying surface finishes. Eliminate tool marks on concrete surfaces.
1. Radius: 1/4 inch(6 mm).

3.6 CONCRETE PLACEMENT

A. Inspection: Before placing concrete, inspect and complete formwork installation, reinforcement steel, and items to be embedded or cast in. Notify other trades to permit installation of their work.

B. Remove snow, ice, or frost from subbase surface and reinforcement before placing concrete. Do not place concrete on frozen surfaces.

C. Moisten subbase to provide a uniform dampened condition at the time concrete is placed. Do not place concrete around manholes or other structures until they are at the required finish elevation and alignment.

D. Comply with requirements and with recommendations in ACI 301 for measuring, mixing, transporting, and placing concrete.

E. Do not add water to concrete during delivery, at Project site, or during placement.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

F. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

G. Consolidate concrete by mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping. Use equipment and procedures to consolidate concrete according to recommendations in ACI 301.
   1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand-spreading and consolidation. Consolidate with care to prevent dislocating reinforcement, dowels, and joint devices.

H. Screed pavement surfaces with a straightedge and strike off. Commence initial floating using bull floats or darbies to form an open textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading dry-shake surface treatments.

I. Curbs and Gutters: When automatic machine placement is used for curb and gutter placement, submit revised mix design and laboratory test results that meet or exceed requirements. Produce curbs and gutters to required cross section, lines, grades, finish, and jointing as specified for formed concrete. If results are not approved, remove and replace with formed concrete.

J. Slip-Form Pavers: When automatic machine placement is used for pavement, submit revised mix design and laboratory test results that meet or exceed requirements. Produce pavement to required thickness, lines, grades, finish, and jointing as required for formed pavement.
   1. Compact subbase and prepare subgrade of sufficient width to prevent displacement of paver machine during operations.

K. When adjoining pavement lanes are placed in separate pours, do not operate equipment on concrete until pavement has attained 85 percent of its 28-day compressive strength.

L. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
   1. When air temperature has fallen to or is expected to fall below 40 deg F(4.4 deg C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F(10 deg C) and not more than 80 deg F(27 deg C) at point of placement.
   2. Do not use frozen materials or materials containing ice or snow.
   3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators, unless otherwise specified and approved in mix designs.

M. Hot-Weather Placement: Place concrete according to recommendations in ACI 305R and as follows when hot-weather conditions exist:
   1. Cool ingredients before mixing to maintain concrete temperature at time of placement below 90 deg F(32 deg C). Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2. Cover reinforcement steel with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
3. Fog-spray forms, reinforcement steel, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

3.7 CONCRETE FINISHING

A. General: Wetting of concrete surfaces during screeding, initial floating, or finishing operations is prohibited.

B. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and the concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats, or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots, and fill low spots. Refloat surface immediately to uniform granular texture.
1. Medium-to-Fine-Textured Broom Finish: Draw a soft bristle broom across float-finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture.

3.8 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and follow recommendations in ACI 305R for hot-weather protection during curing.

B. Begin curing after finishing concrete, but not before free water has disappeared from concrete surface.

C. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound, or a combination of these as follows:
1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
   a. Water.
   b. Continuous water-fog spray.
   c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch(300-mm) lap over adjacent absorptive covers.
2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches(300 mm), and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3.9 PAVEMENT TOLERANCES

A. Comply with tolerances of ACI 117 and as follows:
   1. Elevation: 1/4 inch(6 mm).
   2. Thickness: Plus 3/8 inch(9 mm), minus 1/4 inch(6 mm).
   3. Surface: Gap below 10-foot-(3-m-) long, unleveled straightedge not to exceed 1/4 inch(6 mm).
   4. Lateral Alignment and Spacing of Tie Bars and Dowels: 1 inch(25 mm).
   5. Vertical Alignment of Tie Bars and Dowels: 1/4 inch(6 mm).
   6. Alignment of Tie-Bar End Relative to Line Perpendicular to Pavement Edge: 1/2 inch(13 mm).
   7. Alignment of Dowel-Bar End Relative to Line Perpendicular to Pavement Edge: Length of dowel 1/4 inch per 12 inches(6 mm per 300 mm).
   8. Joint Spacing: 3 inches(75 mm).
   9. Contraction Joint Depth: Plus 1/4 inch(6 mm), no minus.
   10. Joint Width: Plus 1/8 inch(3 mm), no minus.
   11. Accessible Routes, Ramps and Parking Areas: Slopes, including cross slopes, shall not exceed maximums noted on the Drawings.

3.10 PAVEMENT MARKING

A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect.

B. Allow concrete pavement to cure for 28 days and be dry before starting pavement marking.

C. Sweep and clean surface to eliminate loose material and dust.

D. Apply paint with mechanical equipment to produce pavement markings of dimensions indicated with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils(0.4 mm).
   1. Broadcast glass spheres uniformly into wet pavement markings at a rate of 6 lb/gal.(0.72 kg/L).

3.11 WHEEL STOPS

A. Securely attach wheel stops into pavement with not less than two steel dowels embedded in holes cast into wheel stops. Firmly bond each dowel to wheel stop and to pavement. Extend upper portion of dowel 5 inches(125 mm) into wheel stop and lower portion a minimum of 5 inches(125 mm) into pavement.

3.12 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified independent testing and inspection agency to sample materials, perform tests, and submit test reports during concrete placement according to requirements specified in this Article.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Testing Services: Testing shall be performed according to the following requirements:
   1. Sampling Fresh Concrete: Representative samples of fresh concrete shall be obtained according to ASTM C 172, except modified for slump to comply with ASTM C 94.
   2. Slump: ASTM C 143; one test at point of placement for each compressive-strength test, but not less than one test for each day's pour of each type of concrete. Additional tests will be required when concrete consistency changes.
   3. Air Content: ASTM C 231, pressure method; one test for each compressive-strength test, but not less than one test for each day's pour of each type of air-entrained concrete.
   4. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F(4.4 deg C) and below and when 80 deg F(27 deg C) and above, and one test for each set of compressive-strength specimens.
   5. Compression Test Specimens: ASTM C 31/C 31M; one set of four standard cylinders for each compressive-strength test, unless otherwise indicated. Cylinders shall be molded and stored for laboratory-cured test specimens unless field-cured test specimens are required.
   6. Compressive-Strength Tests: ASTM C 39; one set for each day's pour of each concrete class exceeding 5 cu. yd.(4 cu. m), but less than 25 cu. yd.(19 cu. m), plus one set for each additional 50 cu. yd.(38 cu. m). One specimen shall be tested at 7 days and two specimens at 28 days; one specimen shall be retained in reserve for later testing if required.
   7. When frequency of testing will provide fewer than five compressive-strength tests for a given class of concrete, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
   8. When total quantity of a given class of concrete is less than 50 cu. yd.(38 cu. m), Architect may waive compressive-strength testing if adequate evidence of satisfactory strength is provided.
   9. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, current operations shall be evaluated and corrective procedures shall be provided for protecting and curing in-place concrete.
   10. Strength level of concrete will be considered satisfactory if averages of sets of three consecutive compressive-strength test results equal or exceed specified compressive strength and no individual compressive-strength test result falls below specified compressive strength by more than 500 psi(3.4 MPa).

C. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 24 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing agency, concrete type and class, location of concrete batch in pavement, design compressive strength at 28 days, concrete mix proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

D. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as the sole basis for approval or rejection.

E. Additional Tests: Testing agency shall make additional tests of the concrete when test results indicate slump, air entrainment, concrete strengths, or other requirements have not been met, as directed by Architect. Testing agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42, or by other methods as directed.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3.13 REPAIRS AND PROTECTION

A. Remove and replace concrete pavement that is broken, damaged, or defective, or does not meet requirements in this Section.

B. Drill test cores where directed by Engineer when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory pavement areas with portland cement concrete bonded to pavement with epoxy adhesive.

C. Protect concrete from damage. Exclude traffic from pavement for at least 14 days after placement. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of materials as they occur.

D. Maintain concrete pavement free of stains, discoloration, dirt, and other foreign material. Sweep concrete pavement not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes seeding.

B. Provide seed bed preparation, supply and place soil additives, seed, and mulch in all disturbed areas not receiving site improvements, such as roads, walkways, structures, etc.

1.3 DEFINITIONS

A. Finish Grade: Elevation of finished surface of planting soil.

B. Planting Soil: Native or imported topsoil, manufactured topsoil, or surface soil modified to become topsoil; mixed with soil amendments.

C. Subgrade: Surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill immediately beneath planting soil.

1.4 SUBMITTALS

A. Product Data: Refer to Division 01 Section "Submittal Procedures". For each type of product indicated.

B. Planting Schedule shall follow anticipated planting dates.

1.5 MAINTENANCE

A. Begin maintenance immediately after each area is planted and continue until final acceptance.

PART 2 - PRODUCTS

2.1 SEED

A. Seed Species: State-certified seed of grass species, as follows:
   1. Kentucky 31 Fescue.
   2. Annual Rye.
   3. Bermuda.

2.2 PLANTING MATERIALS

A. Topsoil: Free of stones 1 inch (25 mm) or larger in any dimension and other extraneous materials harmful to plant growth.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1. Topsoil Source: Reuse surface soil stockpiled on-site and supplement with imported or manufactured topsoil from off-site sources when quantities are insufficient. Verify suitability of stockpiled surface soil to produce topsoil.

B. Inorganic Soil Amendments:
   1. Lime: ASTM C 602, Class T or O, agricultural limestone containing a minimum 80 percent calcium carbonate equivalent.

C. Fertilizer:
   1. Commercial Fertilizer: Complete fertilizer of neutral character furnished in standard containers that are clearly marked with the name, weight, and guaranteed analysis of the contents and that ensure proper protection in transportation and handling; and in compliance with all local, state, and federal fertilizer laws, with some elements derived from organic sources and containing following percentages of available plant nutrients:
      a. For Warm Season Grasses: Provide fertilizer with 20.5 percentage of nitrogen required to provide not less than 1 pound of actual nitrogen per 100 square feet of lawn area and not less than 4 percent phosphoric acid and 2 percent potassium. Provide nitrogen in a form that will be available to lawn during initial period of growth; at least 50 percent of nitrogen to be organic form, the remainder to be slow release.
      b. For Cool Season Grasses and Other Seeds and Sod: Provide fertilizer with not less than 6 percent total nitrogen, 10 percent available phosphoric acid, and 10 percent soluble potash.

D. Mulches:
   1. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.

PART 3 - EXECUTION

3.1 LAWN PREPARATION

A. Newly Graded Subgrades: Loosen subgrade to a minimum depth of 4 inches (100 mm). Remove stones larger than 1 inch (25 mm) in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
   1. Apply fertilizer directly to subgrade before loosening.
   2. Spread topsoil, apply soil amendments and fertilizer on surface, and thoroughly blend.
   3. Spread topsoil mix to a depth of 4 inches (100 mm) but not less than required to meet finish grades after light rolling and natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.
   4. Delay mixing of fertilizer if planting will not follow within 5 days.

B. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus 1/2 inch (13 mm) of finish elevation. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit fine grading to areas that can be planted within 2 days.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

C. Moisten prepared lawn areas before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

D. Restore areas if eroded or otherwise disturbed after finish grading and before planting.

3.2 SEEDING

A. Sow seed not less than the quantity of seed specified as scheduled.
   1. Spring (March 1 through May 30): Sow 85 percent Kentucky 31 Fescue and 15 percent Bermuda seed.
   2. Summer (June 1 through August 15): Sow 70 percent Bermuda and 30 percent Kentucky 31 Fescue seed.
   3. Fall (August 15 through October 31): Sow 70 percent Kentucky 31 Fescue and 30 percent Annual Rye seed.

B. Rake seed lightly into top 1/8 inch (3 mm) of topsoil, roll lightly, and water with fine spray.

C. Protect all seeded areas by spreading straw mulch. Spread uniformly at a minimum rate of 2 tons/acre (42 kg/92.9 sq. m) to form a continuous blanket 1-1/2 inches (38 mm) in loose depth over seeded areas. Spread by hand, blower, or other suitable equipment.

3.3 MAINTENANCE

A. Begin maintenance immediately after planting.

B. Maintain lawns by watering, fertilizing, weeding, and other operations such as rolling, re-grading and replanting as required to establish an acceptable lawn, smooth and free of stones, weeds, and eroded or bare areas.

C. The standard of acceptability for bare areas is:
   1. No larger than 12 inches in any dimension, nor greater than 15 percent of the lawn.

3.4 CLEANUP AND PROTECTION

A. During landscape work, keep pavements clean and work area in an orderly condition.

B. Protect landscape work and materials from damage due to landscape operations, operations by other contractors and trades and trespassers. Maintain protection during installation and maintenance periods. Treat, repair or replace damaged landscape work as directed.

3.5 INSPECTION AND FINAL ACCEPTANCE

A. When lawn installation is completed, including maintenance, the Engineer will inspect seeding to determine acceptability.

B. An area is considered acceptable if it is represented by a minimum of 100 seedlings per square foot of the permanent species of grass representative of the seed mixture.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

C. Where inspected lawns and grasses are less than 50 percent successful, replace rejected work by reworking the ground, refertilizing, reseeding, and remulching; continue specified maintenance until reinspected by the Engineer and found to be acceptable. Remove rejected plants and materials promptly from project site.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes both potable and fire water-distribution piping and specialties outside the building for the following:
   1. Water services.
   2. Fire-service mains.

1.3 SUBMITTALS

A. Product Data: For the following:
   1. Valves and accessories.
   2. Water meters and accessories.
   3. Backflow preventers and assemblies.
   4. Fire hydrants.

B. Field quality-control test reports.

C. As-Built Drawings: At project closeout, submit as-built drawings of installed potable water and fire system piping and products.

D. Shop Drawings: Submit shop drawings for water systems, showing piping materials, vaults, sizes and show clearances around piping within structures.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. Comply with requirements of utility company supplying water. Include tapping of water mains and backflow prevention.
   2. Comply with standards of authorities having jurisdiction for potable-water-service piping, including materials, installation, testing, and disinfection.
   3. Comply with standards of authorities having jurisdiction for fire-suppression water-service piping, including materials, hose threads, installation, and testing.

B. Piping materials shall bear label, stamp, or other markings of specified testing agency.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with Factory Mutual Global's, FMG, "Approval Guide" or Underwriter's Laboratory, UL "Fire Protection Equipment Directory" for fire-service-main products.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

E. NFPA Compliance: Comply with NFPA 24 for materials, installations, tests, flushing, and valve and hydrant supervision for fire-service-main piping for fire suppression.

F. NSF Compliance:
   1. Comply with NSF 61 for materials for water-service piping and specialties for domestic water.

G. Water distribution piping shall be the product of a recognized manufacturer whose personnel have been regularly engaged in the design and manufacturing of such equipment. The manufacturer must be able to demonstrate experience with the design, fabrication, supply, and successful operation of water distribution piping of similar size and capacity. The manufacturer shall demonstrate upon the request of the Engineer that:
   1. They maintain a reasonable stock of spare parts for this equipment.
   2. They employ sufficient qualified servicing and operation control advice.

1.5 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
   1. Notify Engineer and Owner not less than three days in advance of proposed utility interruptions.
   2. Do not proceed with utility interruptions without Engineer's/Owner's permission.

1.6 COORDINATION

A. Coordinate connection to water main with utility company.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
   1. Products: Subject to compliance with requirements, provide one of the products specified.
   2. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PIPING MATERIALS

A. Refer to Part 3 of this Section, "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2.3 PIPE AND FITTINGS

A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, Pressure Class 350 unless otherwise indicated with mechanical-joint, bell- and plain-spigot end unless grooved or flanged ends are indicated.
   1. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
      a. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

B. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, Pressure Class 350 unless otherwise indicated, with push-on-joint, bell- and plain-spigot end unless grooved or flanged ends are indicated.
   1. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
      a. Gaskets: AWWA C111, rubber.

C. Soft Copper Tube: ASTM B 88, Type K(ASTM B 88M, Type A), water tube, annealed temper.
   1. Copper Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint pressure type. Furnish only wrought-copper fittings if indicated.

2.4 JOINING MATERIALS

A. Brazing Filler Metals: AWS A5.8, BCuP Series.

B. Soldering Flux: ASTM B 813, water-flushable type.

C. Solder Filler Metal: ASTM B 32, lead-free type with 0.20 percent maximum lead content.

2.5 GATE VALVES

A. AWWA, Cast-Iron, Gate Valves:
   1. Manufacturers:
      a. American AVK Co.; Valves & Fittings Div.
      b. American Cast Iron Pipe Co.; American Flow Control Div.
      c. American Cast Iron Pipe Co.; Waterous Co. Subsidiary.
      d. Crane Co.; Crane Valve Group; Stockham Div.
      e. East Jordan Iron Works, Inc.
      f. Mueller Co.; Water Products Div.
      g. McWane, Inc.; Clow Valve Co. Div. (Oskaloosa).
      h. McWane, Inc.; Kennedy Valve Div.
      i. McWane, Inc.; Tyler Pipe; Utilities Div.
      j. NIBCO INC.
      k. United States Pipe and Foundry Company.
      l. Or approved equal.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2. Nonrising-Stem, Resilient-Seated Gate Valves: AWWA C509, gray- or ductile-iron body and bonnet; with bronze or gray- or ductile-iron gate, resilient seats, bronze stem, and stem nut.
    a. Minimum Working Pressure: 200 psig(1380 kPa).
    b. End Connections: Mechanical joint.
    c. Interior Coating: Complying with AWWA C550.
3. OS&Y, Rising-Stem, Resilient-Seated Gate Valves: AWWA C509, cast-iron or ductile-iron body and bonnet, outside screw and yoke; with bronze or gray- or ductile-iron gate, resilient seats, and bronze stem.
    a. Minimum Working Pressure: 200 psig(1380 kPa).
    b. End Connections: Flanged.

2.6 GATE VALVE ACCESSORIES AND SPECIALTIES

A. Tapping-Sleeve Assemblies: Comply with MSS SP-60. Include sleeve and valve compatible with drilling machine.
1. Manufacturers:
    a. American Cast Iron Pipe Co.; Waterous Co. Subsidiary.
    b. East Jordan Iron Works, Inc.
    c. Mueller Co.; Water Products Div.
    d. McWane, Inc.; Clow Valve Co. Div. (Oskaloosa).
    e. McWane, Inc.; Kennedy Valve Div.
    f. McWane, Inc.; M & H Valve Company Div.
    g. United States Pipe and Foundry Company.
    h. Or approved equal.
2. Tapping Sleeve: Cast- or ductile-iron or stainless-steel, two-piece bolted sleeve with flanged outlet for new branch connection. Include sleeve matching size and type of pipe material being tapped and with recessed flange for branch valve.
3. Valve: AWWA, cast-iron, nonrising-stem, resilient-seated gate valve with one raised face flange mating tapping-sleeve flange.

B. Valve Boxes: Comply with AWWA M44 for cast-iron valve boxes. Include top section, adjustable extension of length required for depth of burial of valve, plug with lettering "WATER," bottom section with base of size to fit over valve, and approximately 5-inch-(125-mm-) diameter barrel.
1. Operating Wrenches: Steel tee-handle with one pointed end, stem of length to operate deepest buried valve, and socket matching valve operating nut.

C. Vertical-Type Indicator Posts: UL 789, FM-approved, cast-iron body with operating wrench, extension rod, and adjustable cast-iron barrel of length required for depth of burial of valve.

2.7 CORPORATION VALVES AND CURB VALVES

A. Manufacturers:
1. Amcast Industrial Corporation; Lee Brass Co.
2. Ford Meter Box Company, Inc. (The).
3. Mueller Co.; Water Products Div.
4. Jones, James Company.
5. Master Meter, Inc.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

6. McDonald, A. Y. Mfg. Co.
7. Red Hed Manufacturing Co.
8. Or approved equal.

B. Service-Saddle Assemblies: Comply with AWWA C800. Include saddle and valve compatible with tapping machine.
   1. Service Saddle: Copper alloy with seal and AWWA C800, threaded outlet for corporation valve.
   2. Corporation Valve: Bronze body and ground-key plug, with AWWA C800, threaded inlet and outlet matching service piping material.

C. Curb Valves: Comply with AWWA C800. Include bronze body, ground-key plug or ball, and wide tee head, with inlet and outlet matching service piping material.

D. Service Boxes for Curb Valves: Similar to AWWA M44 requirements for cast-iron valve boxes. Include cast-iron telescoping top section of length required for depth of burial of valve, plug with lettering "WATER," bottom section with base of size to fit over curb valve, and approximately 3-inch-(75-mm-) diameter barrel.
   1. Shutoff Rods: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and slotted end matching curb valve.

2.8 PROTECTIVE ENCLOSURES

A. Manufacturers:
   1. G&C Enclosures, Inc.
   2. Hot Box, Inc.
   3. HydroCowl, Inc.
   4. Watts Water Technologies, Inc.; Water Products Div.
   5. Or approved equal.

B. Protective Enclosures, General: ASSE 1060, outdoor weather-resistant enclosure designed to protect aboveground water piping equipment or specialties from vandalism. Include size and dimensions indicated but not less than those required for access and service of protected unit.

C. Freeze-Protection Enclosures: Insulated and with heat source to maintain minimum internal temperature of 40 deg F (4 deg C) when external temperatures reach as low as minus 34 deg F (minus 36 deg C).
   1. Class I-V: For pressure or atmospheric vacuum breaker equipment or devices. Include drain opening in housing.
      a. Housing: Reinforced-aluminum or -fiberglass construction.
         1) Drain opening for units with drain connection.
         2) Access doors with locking devices.
         3) Insulation inside housing.
         4) Anchoring devices for attaching housing to concrete base.
      b. Electric heater with self-limiting temperature control.

D. Precast concrete base of dimensions required to extend at least 6 inches(150 mm) beyond edges of enclosure housings. Include openings for piping.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Refer to Division 31 Section "Site Excavation, Backfilling, and Compaction" for excavating, trenching, and backfilling.

B. Underground Water-Service Piping: Use the following piping materials for each size range:
   1. NPS 3/4 to NPS 2(DN 20 to DN 50): Soft copper tube, Type K(Type A); wrought-copper fittings; and soldered joints.
   2. NPS 2-1/2 to NPS 3-1/2(DN 65 to DN 90): Soft copper tube, Type K(Type A); wrought-copper fittings; and soldered joints.
   3. NPS 4(DN 100) and Larger (DN 125 and DN 150): Ductile-iron, push-on-joint pipe; ductile-iron, push-on-joint fittings; and gasketed joints.

C. Underground Fire-Service-Main Piping: Ductile-iron, push-on-joint pipe; ductile-iron, push-on-joint fittings; and gasketed joints.

D. Underground Combined Water-Service and Fire-Service-Main Piping: Ductile-iron, push-on-joint pipe; ductile-iron, push-on-joint fittings; and gasketed joints.

3.2 VALVE APPLICATIONS

A. General Application: Use mechanical-joint-end valves for NPS 3(DN 80) and larger underground installation. Use threaded- or flanged-end valves for installation in vaults. Use UL/FMG, nonrising-stem gate valves for installation with indicator posts. Use corporation valves and curb valves with ends compatible with piping, for NPS 2(DN 50) and smaller installation.

B. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
   1. Underground Valves, NPS 3(DN 80) and Larger: AWWA, cast-iron, nonrising-stem, resilient-seated, gate valves with valve box.
   2. Underground Valves, NPS 4(DN 100) and Larger: UL/FMG, Cast-iron, nonrising-stem gate valves.

3.3 JOINT CONSTRUCTION

A. Make pipe joints according to the following:
   1. Ductile-Iron Piping, Gasketed Joints for Water-Service Piping: AWWA C600 and AWWA M41.
   2. Ductile-Iron Piping, Gasketed Joints for Fire-Service-Main Piping: UL 194.
   3. Copper Tubing Soldered Joints: ASTM B 828. Use flushable flux and lead-free solder.
   4. Dissimilar Materials Piping Joints: Use adapters compatible with both piping materials, with OD, and with system working pressure.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3.4 PIPING INSTALLATION

A. Water-Main Connection: Tap water main according to requirements of water utility company and of size and in location indicated.

B. Make connections larger than NPS 2(DN 50) with tapping machine according to the following:
   1. Install tapping sleeve and tapping valve according to MSS SP-60.
   2. Install tapping sleeve on pipe to be tapped. Position flanged outlet for gate valve.
   3. Use tapping machine compatible with valve and tapping sleeve; cut hole in main. Remove tapping machine and connect water-service piping.
   4. Install gate valve onto tapping sleeve. Comply with MSS SP-60. Install valve with stem pointing up and with valve box.

C. Make connections NPS 2(DN 50) and smaller with drilling machine according to the following:
   1. Install service-saddle assemblies and corporation valves in size, quantity, and arrangement required by utility company standards.
   2. Install service-saddle assemblies on water-service pipe to be tapped. Position outlets for corporation valves.
   3. Use drilling machine compatible with service-saddle assemblies and corporation valves. Drill hole in main. Remove drilling machine and connect water-service piping.
   4. Install corporation valves into service-saddle assemblies.
   5. Install manifold for multiple taps in water main.
   6. Install curb valve in water-service piping with head pointing up and with service box.

D. Comply with NFPA 24 for fire-service-main piping materials and installation.

E. Install ductile-iron, water-service piping according to AWWA C600 and AWWA M41.

F. Install copper tube and fittings according to CDA's "Copper Tube Handbook."

G. Install PVC, AWWA pipe according to AWWA M23 and ASTM F 645.

H. Bury piping with depth of cover over top at least 30 inches(750 mm), with top at least 12 inches(300 mm) below level of maximum frost penetration.

I. Extend water-service piping and connect to water-supply source and building water piping systems at outside face of building wall in locations and pipe sizes indicated.
   1. Terminate water-service piping at building wall until building water piping systems are installed. Terminate piping with caps, plugs, or flanges as required for piping material. Make connections to building water piping systems when those systems are installed.

J. Install underground piping with restrained joints at horizontal and vertical changes in direction. Use restrained-joint piping, thrust blocks, anchors, tie-rods and clamps, and other supports.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

K. Water Piping Installation Parallel With Sanitary Sewer Piping:
   1. Normal Conditions: Water piping shall be laid at least 10 feet horizontally from a sewer or sewer manhole whenever possible. Distance shall be measured edge to edge.
   2. Unusual Conditions: When local conditions prevent a horizontal separation of 10 feet, water piping may be laid closer to a sewer or sewer manhole provided:
      a. Bottom (invert) of the water piping shall be at least 18 inches above the top (crown) of the sewer piping.
      b. Where this vertical separation cannot be obtained, sewer piping shall be constructed of AWWA-approved water pipe, pressure tested in place without leakage prior to backfilling.
      c. Sewer manhole shall be of watertight construction and tested in place.

L. Installation of Water Piping Crossing Sanitary Sewer Piping:
   1. Normal Conditions: Water piping crossing above sewer piping shall be laid to provide a separation of at least 18 inches between the bottom of the water piping and the top of the sewer piping.
   2. Unusual Conditions: When local conditions prevent a vertical separation described above, the following construction shall be used:
      a. Sewer piping passing over or under water piping shall be constructed of AWWA-approved water piping, pressure tested in place without leakage prior to backfilling.
      b. Water piping passing under sewer piping shall, in addition, be protected by providing the following. A vertical separation of at least 18 inches between bottom of sewer piping and top of water piping; adequate structural support for sewer piping to prevent excessive deflection of joints and settling on and breaking of water piping; and that the length (minimum 18 feet) of water piping be centered at the point of crossing so that joints shall be equidistant and as far as possible from sewer piping.

M. Sanitary Sewer Manholes: No water piping shall pass through or come in contact with any part of a sewer manhole.

3.5 ANCHORAGE INSTALLATION

A. Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches. Include anchorages for the following piping systems:
   1. Gasketed-Joint, Ductile-Iron, Water-Service Piping: According to AWWA C600.
   2. Fire-Service-Main Piping: According to NFPA 24.
   3. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

3.6 VALVE INSTALLATION

A. AWWA Gate Valves: Comply with AWWA C600 and AWWA M44. Install each underground valve with stem pointing up and with valve box.

B. Corporation Valves and Curb Valves: Install each underground curb valve with head pointed up and with service box.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3.7 DETECTOR CHECK VALVE INSTALLATION

A. Install detector check valves for proper direction of flow. Install bypass with water meter, gate valves on each side of meter, and check valve downstream from meter.

B. Support detector check valves, meters, shutoff valves, and piping on brick or concrete piers.

3.8 WATER-METER INSTALLATION

A. Install water meters, piping, and specialties according to utility company's written requirements.

B. Water Meters: Install compound-type water meters, NPS 3(DN 80) and larger, in meter vaults. Include shutoff valves on water-meter inlets and outlets and valved bypass around meters. Support meters, valves, and piping on brick or concrete piers.

3.9 BACKFLOW-PREVENTER INSTALLATION

A. Install backflow preventers of type, size, and capacity indicated. Include valves and test cocks. Install according to requirements of plumbing and health department and authorities having jurisdiction.

B. Do not install backflow preventers with relief drain in vault or other space subject to flooding.

C. Do not install bypass piping around backflow preventers.

D. Support NPS 2-1/2(DN 65) and larger backflow preventers, valves, and piping near floor and on galvanized steel pipe stands.

3.10 VAULT CONSTRUCTION AND INSTALLATION

A. Install precast concrete vaults according to ASTM C 891.

B. Connect drain outlet to storm drainage piping or daylight.

3.11 PROTECTIVE ENCLOSURE INSTALLATION

A. Install concrete base level and with top approximately 2 inches(50 mm) above grade.

B. Install protective enclosure over valves and equipment.

C. Anchor protective enclosure to concrete base.

3.12 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping and specialties.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Connect water-distribution piping to utility water main. Use tapping sleeve and tapping valve or service clamp and corporation valve.

C. Connect water-distribution piping to interior domestic-water piping.

3.13 FIELD QUALITY CONTROL

A. Piping Tests: Conduct piping tests before joints are covered and after thrust blocks have hardened sufficiently. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water.

B. Hydrostatic Tests: Test at not less than 1-1/2 times working pressure for 2 hours.
   1. Increase pressure in 50-psig(350-kPa) increments and inspect each joint between increments. Hold at test pressure for 1 hour; decrease to 0 psig (0 kPa). Slowly increase again to test pressure and hold for 1 more hour. Maximum allowable leakage is 2 quarts(1.89 L) per hour per 100 joints. Remake leaking joints with new materials and repeat test until leakage is within allowed limits.

C. Prepare reports of testing activities.

3.14 IDENTIFICATION

A. Install continuous underground detectable warning wire during backfilling of trench for underground water-service piping. Locate 12 inches directly above piping.

3.15 FLUSHING AND DISINFECTION

A. Preliminary Flushing: Before chlorination, fill lines to remove all air pockets and flush to remove particulates. Flushing velocity shall not be less than 2.5 feet per second.

B. Disinfection Tests: Conduct disinfection tests in accordance with AWWA C651.
   1. During construction, take precautions to protect pipe interiors, fittings, and valves against contamination. When pipe laying is not in progress (e.g., at end of the day's work), place watertight plugs in the ends of all pipe already in the trench; if water accumulates in the trench, leave the plugs in place until the trench is dry. Complete the joints of all pipes in the trench before stopping work for any reason.
   2. If dirt or other foreign material that has gotten into a pipe will not, in the opinion of the Owner, be removed by flushing, clean the interior of the pipe, and swab with a disinfecting solution of 5 percent hypochlorite.
   3. Make water flow from the existing distribution system or some other source approved by the Owner into the newly laid piping, and add chlorine to it. Feed water into the pipe, and chlorine into the water, at constant, measured rates so proportioned that that chlorine concentration in the water in the pipe is kept at a minimum of 50 mg/l available chlorine. To ensure that this concentration is maintained, measure the chlorine residual at regular intervals.
   4. Table I shows how much chlorine is needed for each 100 feet of line for pipes of various diameters. A 1 percent chlorine solution may be prepared either with 1 pound of calcium hypochlorite for each 8.5 gallons of water or sodium hypochlorite.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

TABLE I
CHLORINE REQUIRED TO PRODUCE A 50 MG/ℓ CONCENTRATION
IN 100 FEET OF PIPE, BY DIAMETER

Pipe Size Inches	100% Chlorine Pounds	1% Chlorine Solutions (Gallons)
4	0.027	0.33
6	0.061	0.73
8	0.108	1.30
10	0.170	2.04
12	0.240	2.88
14	0.328	3.96
16	0.428	5.12
18	0.540	6.48
20	0.680	8.00
24	0.980	11.52

5. While chlorine is being applied, manipulate valves so that the treatment dosage will not flow back into the line that is supplying the water. Continue application of chlorine until the entire line being treated is filled with the chlorine solution. Then retain the chlorinated water in the line for at least 24 hours, during which time all valves and hydrants in the line being treated shall be operated so that appurtenances can also be disinfected. After 24 hours, the treated water shall have a chlorine concentration of at least 25 mg/l throughout the line.

C. Final Flushing: Conduct final flushing in accordance with AWWA C651.

1. After applicable retention period, flush heavily chlorinated water from the line until chlorine concentration in water leaving the main is no higher than that generally prevailing in the system, or less than 1 mg/l. Perform such flushing only at sites where Owner has approved. If no approved point of discharge is available, neutralizing chemicals must be applied to the water in order to neutralize the chlorine residual. The amount of chemicals required to neutralize various residual chlorine concentrations in 100,000 gallons of water are shown in Table II.

TABLE II
REQUIRED CHEMICALS TO NEUTRALIZE CHLORINE CONCENTRATIONS

Residual Chlorine Concentration	Chemical Required: Sulfur Dioxide (SO_2)		Sodium Bisulfite ($NaHSO_3$)		Sodium Sulfite (Na_2SO_3)		Sodium Thiosulfate (Na_2S2O_3-$5H_2O$)	
mg/ℓ	*lb*	*(kg)*	*Lb*	*(kg)*	*lb*	*(kg)*	*lb*	*(kg)*
1	0.8	(.36)	1.2	(.54)	1.4	(.64)	1.2	(.54)
2	1.7	(.77)	2.5	(1.13)	2.9	(1.32)	2.4	(1.09)
10	8.3	(3.76)	12.5	(5.67)	14.6	(6.62)	12.0	(5.44)
50	41.7	(18.91)	62.6	(28.39)	73.0	(33.11)	60.0	(27.22)

2. The velocity of water used to flush a line shall be at least 2.5 fps. The flow rates required to produce this velocity in various sizes of pipe are shown in Table III.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

TABLE III
REQUIRED OPENINGS TO FLUSH PIPELINES
(40 PSI RESIDUAL PRESSURE)

Pipe Size (Inches)	Flow Required to Produce 2.5 fps Velocity (gpm)	Orifice Size (Inches)	Hydrant Outlet Nozzles	
			Number	Size (Inches)
4	100	15/16	1	2-1/2
6	220	1-3/8	1	2-1/2
8	390	1-7/8	1	2-1/2
10	610	2-5/16	1	2-1/2
12	880	2-13/16	1	2-1/2
14	1,200	3-1/4	2	2-1/2
16	1,565	3-5/8	2	2-1/2
18	1,980	4-3/16	2	2-1/2
20	2,440	---	2	2-1/2
24	3,470	---	2	2-1/2

3. Once a line has been flushed, test to make certain that the residual chlorine in the water is within acceptable limits.
4. It must be noted that flushing is no substitute for taking preventative measures before and during the laying of water lines. Certain contaminants—especially those in caked deposits—are difficult or even impossible to remove by flushing, no matter how high the velocity. Furthermore, in pipes with diameters of 16 inches or more, it can be difficult to achieve even the minimum recommended flushing velocity of 2.5 fps.

D. Bacteriological Tests: Conduct bacteriological tests in accordance with AWWA C651.
1. After a water line has undergone final flushing but before it is placed into service, collect a sample for bacteriological testing from the end of that line. In the case of extremely long lines, take additional samples if Owner so directs.
2. Collect these samples in sterile bottle treated with sodium thiosulfate. Do not use a hose or fire hydrant to collect samples. One suggested sampling method is to install a standard corporation cock in the line with a copper tube gooseneck assembly; after the samples have been taken, the gooseneck assembly can be removed and retained for later use.
3. Take the samples collected to an approved laboratory to be tested for bacteriological quality in order to determine if they contain any coliform organisms. If the initial disinfection fails to produce satisfactory samples, repeat disinfection until satisfactory samples are obtained.
4. When the samples tested are found to be satisfactory, the water line may be placed in service.

E. Disinfection Procedure After Cutting Into or Repairing Existing Lines:
1. The procedures outlined above apply primarily to cases in which the lines are wholly or partially dewatered.
2. However, leaks or breaks that are repaired with clamping devices while the lines remain full of water under the pressure present little danger of contamination and require no disinfection.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3. When an existing line is opened, whether by accident or design, the excavated area could be wet and contaminated because of the presence of sewers nearby. The danger of contamination from such pollution can be lessened if liberal quantities of hypochlorite are applied to the open trenches. It is better to use tablets for disinfection in such cases because they dissolve slowly and continue to release hypochlorite as water is pumped from the excavation site.
4. Where practical, treat the lines by the slug method in accordance with AWWA C651-92.
5. The following disinfection procedure is considered the minimum that may be used when existing lines are repaired:
    a. Swab the interior of all pipes and fittings (particularly couplings and tapping sleeves) that rare to be used in repairing an existing line with a solution of 5 percent hypochlorite before installing them.
    b. The most practical means of removing contamination introduced into a line during repairs is to give the line a thorough flushing. If the locations of valves and hydrants make it possible, flushing in both directions is recommended. Start flushing as soon as repairs are completed, and continue until all discolored water is eliminated.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SCOPE

A. Work covered by this section includes furnishing all materials, labor, and equipment required to furnish, install, and test fire hydrants and yard hydrants and accessories as specified herein and/or shown on the Drawings.

1.3 SHOP DRAWINGS AND ENGINEERING DATA

A. Complete shop drawings and engineering data shall be submitted to the Engineer in accordance with requirements of Division 01 Section "Submittal Procedures".

1.4 STORAGE AND PROTECTION

A. Hydrants shall be stored and protected in accordance with manufacturer's recommendations.

1.5 SHOP PAINTING

A. Hydrants and accessories shall be cleaned, shop primed, and shop painted in accordance with requirements Division 09 Section "Protective Coatings".

1.6 OPERATION AND MAINTENANCE DATA

A. Submit complete operation and maintenance data on the hydrants in accordance with requirements of Division 01 Section "Operation and Maintenance Data".

1.7 GUARANTEE

A. Provide a guarantee against defective or deficient equipment and workmanship.

1.8 QUALITY ASSURANCE

A. The manufacturer of the fire hydrants shall furnish a written certification to the Engineer that all hydrants furnished comply with all applicable requirements of AWWA C502, latest edition.

PART 2 - PRODUCTS

2.1 FIRE HYDRANTS

A. Fire hydrants shall be of the dry-barrel, compression type and shall conform to applicable requirements of AWWA C502, latest edition. Fire hydrants shall be cast iron, bronze mounted, suitable for a working pressure of 150 psi. Name of the manufacturer and size of the main valve shall be cast upon the hydrant in raised letters.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Hydrants shall be constructed in a manner that will permit withdrawal of internal working parts without disturbing the barrel or casing. Valve shall be compression type, opening against pressure and so constructed that the main valve will remain closed should the hydrant be broken off by traffic accident. Valve opening shall be at least 5-1/4 inches in diameter and shall have a net area of waterway at the smallest part of not less than 120 percent of the valve opening when the valve is wide open. There shall be no chattering or water hammer under any conditions of operation.

C. Barrel shall be made in two pieces with flanged joint above the finished grade or ground line. Lower barrel shall be fluted for strength and tapered to prevent frost heave. Ground line flange shall be of the break-away type. Two positive acting, bronze fitted drain valves shall be provided in the hydrant shoe automatically to open and provide rapid and complete drainage of the hydrant barrel when the main valve is closed.

D. Hydrant bonnet shall be designed to protect the operating head against rust, corrosion, and dirt. The stuffing box shall have bronze glands and O-ring seal. Suitable means shall be provided for lubricating the stem threads, O-ring, and bearing surfaces in the bonnet.

E. The main valve rod shall be of steel and shall be bronze sheathed where it passes through the stuffing box. Stem shall be equipped with a two-piece safety or breakable stem coupling to prevent damage to the stem when hydrant is hit by a vehicle. A positive stop shall be provided to permit full opening of the valve and prevent over-travel of the stem.

F. Direction of opening shall be counterclockwise and shall be cast on the head. Operating nut shall be National Standard, 1-1/2-inch, pentagon shaped.

G. Two 2-1/2-inch hose nozzles and one 4-1/2-inch pumper nozzle shall be provided on each hydrant. Hose and pumper nipples shall be of bronze or non-corrosive metal, and threads shall be National Standard in accordance with NFPA Standard No. 194. Nipple caps shall be securely chained to the barrel with galvanized, non-kinking chains.

H. Hydrants that are to be connected to cast iron pipe shall be equipped with mechanical joint inlet with gland, gaskets, bolts, and nuts. Suitable ring-tight or fluid-tight inlets shall be provided on hydrants that are to be connected to cement asbestos pipe. Inlet bell shall have two lugs for harness restraint.

I. After fabrication, all exterior aboveground ferrous surfaces shall be blast-cleaned and painted at the shop with one coat of zinc chromate primer conforming to Federal Specification TT-P-636 and one coat of compatible alkyd enamel. Color shall be fire hydrant red all interior and belowground, non-machined ferrous surfaces shall be blast-cleaned and painted at the shop with two coats of asphaltic varnish conforming to Federal Specification TT-V-51c.

J. Contractor shall furnish the Owner with two (2) heavy-duty operating wrenches for use with the hydrants. Wrenches shall fit operating nut, hose nozzle caps, and pin type hose couplings. Cost of wrenches shall be included in the price bid for furnishing and installing fire hydrants, and no separate payment will be made therefor.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

K. Fire hydrants shall be as manufactured by Mueller, M&H (Dresser), Kennedy, or approved equal.

2.2 YARD HYDRANTS

A. Yard hydrants shall be of the nonfreezing, compression, post type hydrant with self-draining barrel as manufactured by Zurn Industries, Model Z1390 or approved equal. Yard hydrants shall be suitable for 125 PSI static pressure.

B. Yard hydrants shall have a brass casing and base, bronze seats, resilient-faced disc, O-ring stem seal, bronze or stainless steel stem, and galvanized steel barrel.

C. Yard hydrants shall be furnished with 2-inch threaded female inlet connection per ANSI B2.1 and threaded 1-1/2-inch male outlet hose connection. A "T" or wheel handle shall be furnished to operate the valve.

D. All internal working parts shall be readily accessible and removable through the top for ease of maintenance.

2.3 SPARE PARTS

A. The following spare parts shall be furnished for hydrants furnished under this section, where applicable:

1.	Packing, O-rings, and Gaskets	One set each hydrant
2.	Main Valve Disc	One each hydrant
3.	Drain Valve Facing	One each hydrant
4.	Break-away Flange Repair Kit	One set with Stem Coupling
5.	Seat Wrench	One each type required
6.	Lubricants	One year supply

B. Spare parts shall be suitably protected against corrosion and impact to withstand long-term storage. Parts shall be clearly identified with the manufacturer's name and number and the equipment to which they belong.

PART 3 - EXECUTION

3.1 FACTORY TESTING

A. Each hydrant shall be tested at the factory at a hydrostatic pressure of 300 psig in accordance with AWWA C502, Section 5. Hydrants shall be tested in both open and closed positions. Hydrants shall be completely drained and closed before shipment.

3.2 INSTALLATION

A. Hydrants shall be installed at the locations and in the manner shown on the Drawings. Hydrants shall be inspected, cleaned, and tested for operation prior to installation.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Fire hydrants shall be isolated from the water supply main with a buried gate valve not less than 6 inches in size. Hydrants shall be installed in a suitable rock drain and anchored against thrust as shown on the Drawings. Upper barrel joint shall be located approximately 2 inches above ground level. Barrel extensions shall be furnished as necessary.

C. Each yard hydrant shall be isolated from the water supply by a 2-inch gate valve as shown on the Drawings.

D. After installation, each valve shall be tested in the presence of the Engineer for proper operation and leak-tightness. Any leaks shall be corrected.

E. Following installation and testing, exposed ferrous surfaces of hydrants shall be field painted with alkyd system ferrous metal finish in accordance with Division 09 "Protective Coatings".

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes requirements for sanitary sewer (gravity) piping.

B. Related Sections include the following:
   1. Division 31 Section "Site Excavation, Backfilling, and Compaction" for excavation requirements.
   2. Division 32 Section “Asphalt Paving” for open trench installation repair work.

1.3 DEFINITIONS / STANDARDS

A. The following are industry abbreviations for metal and plastic materials:
   1. DIP: Ductile iron pipe.
   2. HDPE: High-density polyethylene.

B. Buried piping shall be of the bell and spigot, butt fusion, electrofusion, or sleeve coupling type.

C. Non-buried piping shall have flanged ends, unless otherwise noted on the Drawings.

1.4 SUBMITTALS

A. Product Data:
   1. Ductile iron pipe.
   2. Ductile iron fittings.
   3. Ductile iron flanged pipe.
   4. Mechanical joint restraint devices.
   5. Flanged coupling adapters.
   6. Flexible expansion joint.
   7. Compression couplings.
   8. Line markers.
   9. Detection wire.

1.5 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of piping and specialties and are based on the specific system indicated.

B. Comply with regulatory requirements of local, state and federal agencies having jurisdiction.

C. Piping material shall bear label, stamp, or other markings of specified testing agency.

D. Comply with ASTM F645 for selection, design, and installation of thermoplastic water piping.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

E. Comply with ASTM specifications for materials.

F. The pipe manufacturer must furnish the Engineer a notarized certificate stating that the pipe furnished has been manufactured and tested in accordance with the applicable standards.

G. The length of each individual piece of ductile iron pipe shipped must be plainly marked on each piece of pipe. Each piece of pipe shall bear the manufacturer's name or trademark, the year in which it was produced, and the letters "DI" or the word "DUCTILE".

H. The ductile iron pipe shall be the product of a recognized manufacturer whose personnel have been regularly engaged in the design and manufacture of ductile iron pipe. The manufacturer must be able to demonstrate experience with design, fabrication, and supply. The manufacturer shall demonstrate at the request of the Engineer that:
   1. They employ sufficient qualified technical personnel to insure adequate service and operational control advice.
   2. They maintain a reasonable stock of ductile iron pipe.

I. Customer Inspection:
   1. The Owner, Engineer, or designated representative(s) shall be entitled to inspect pipes and witness the pipe manufacturing.
   2. Manufacturer's Notification to Customer: Should the Owner request to see specific pipes during any phase of the manufacturing process, the Manufacturer must provide the Owner with adequate advance notice of when and where the production of those pipes will take place.

J. If ductile iron pipe is used, the pipe manufacturer is to furnish the Engineer a certificate of inspection, sworn to by the factory inspector in the presence of a notary public, stating that the pieces of pipe in the shipment were made and tested in accordance with ANSI A21.51 and that they were subjected to an withstood a hydrostatic pressure of 500 PSI. Each statement is to give the number of pieces of pipe in the shipment, the length of each piece of pipe, and the identification number of each piece of pipe making up the shipment. In addition, the weight of each individual piece of pipe making up the shipment is to be listed opposite the identification number of each pipe length and attached to the certificate of inspection.

K. Gaskets shall be suitable for service conditions and loads indicated. Conflicts with products listed shall be brought to the Engineer's attention before proceeding with ordering materials.

L. Joint lubricant shall be suitable for service conditions and pipe material and as recommended by the pipe manufacturer.

1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Delivery: Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.

B. Storage:
   1. Protect stored piping from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

C. Handling: Protect flanges, fittings, and specialties from moisture and dirt.

1.7 GENERAL REQUIREMENTS

A. Pipe material for sewer lines shall be ductile iron unless otherwise shown on the drawings.

B. Shop drawings and manufacturer certification are required for all products specified in this section.

C. Refer to other sections for items affecting gravity sewers. Coordinate this work with that specified by other sections for timely execution.

D. Each material type of gravity pipe and associated fittings (DIP, etc.) supplied under this section shall be provided by the same manufacturer.

E. Refer to Division 31 Section "Site Excavation, Backfilling, and Compaction" for additional requirements.

PART 2 - PRODUCTS

2.1 DUCTILE IRON PIPE

A. Ductile iron pipe shall conform to the requirements of ANSI 21.151/AWWA C151 latest revision for ductile iron pipe centrifugally cast in metal or sand-lined molds. It shall be made and tested in accordance with ASTM A536, latest revision. The pipe shall be able to withstand a hydrostatic pressure of 500 psi.

B. The design thickness shall be that specified by ANSI A21.50/AWWA C150 latest revision except that all pipe with a diameter of 12 inches or less shall be Pressure Class 350 and all pipe with a diameter 14 inches or greater shall be Pressure Class 250 unless determined otherwise by the Owner or Engineer. Refer to process piping specification and Contract Drawings for specific materials.

C. Coatings and Lining:
1. The pipe shall be coated externally with an asphaltic coating approximately 1 mil thick in accordance with ANSI A21.51/AWWA C151.
2. The pipe and fittings shall be lined with Protecto 401. The interior surface preparation and coating shall meet the following requirements:
   a. Condition of Items Prior to Surface Preparation: All ductile iron pipe and fittings shall be delivered to the application facility without asphalt, cement lining, or any other lining on the interior surface. Because removal of old linings may not be possible, the intent of this specification is that the entire interior of the ductile iron pipe (DIP) and fittings shall not have been lined with any substance prior to the application of the specified lining material and no coating shall have been applied to the first six inches of the exterior of the spigot ends.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

b. Lining Material: The standard of quality is Protecto 401 Ceramic Epoxy. The material shall be an amine cured novalac epoxy containing at least 20% by volume of ceramic quartz pigment. Any request for substitution must be accompanied by a successful history of lining pipe and fittings for sewer service, a test report verifying the following properties, and a certification of the test results.
   1) A permeability rating of 0.00 when tested according to Method A of ASTM E-96-66, Procedure A with a test duration of 30 days.
   2) The following test must be run on coupons from factory lined ductile iron pipe:
      a) ASTM B-117 Salt Spray (scribed panel) – Results to equal 0.0 undercutting after two (2) years.
      b) ASTM G-95 Cathodic Disbondment 1.5 volts at 77 degrees F. Results to equal no more than 0.5mm undercutting after 30 days.
      c) Immersion Testing rated using ASTM D-714-87.
         - 20% Sulfuric Acid – No effect after two (2) years.
         - 25% Sodium Hydroxide – No effect after two (2) years.
         - 160 degrees F Distilled Water – No effect after two (2) years.
         - 120 degrees F Tap Water (scribed panel) – 0.0 undercutting after two (2) years with no effect.
   3) An abrasion resistance of no more than 4 mils (0.10mm) loss after one million cycles – European Standard EN 598: 1994 Section 7.8 Abrasion Resistance.

c. Application:
   1) Applicator: The lining shall be applied by a competent firm with a successful history of applying linings to the interior of ductile iron pipe and fittings.
   2) Surface Preparation: Prior to abrasive blasting, the entire area to receive the protective compound shall be inspected for oil, grease, etc. Any areas - where oil, grease, or any substance which can be removed by solvent is present - shall be solvent cleaned using the guidelines outlined in DIPRA-1 Solvent Cleaning. After the surface has been made free of grease, oil, or other substances, all areas to receive the protective compounds shall be abrasive blasted using compressed air nozzles with sand or grit abrasive media. The entire surface to be lined shall be struck with the blast media so that all rust, loose oxides, etc. are removed from the surface. Only slight stains and tightly adhering annealing oxide may be left on the surface. Any area where rust reappears before lining must be reblasted.
   3) Lining: After the surface preparation and within 8 hours of surface preparation, the interior of the pipe shall receive 40 mils nominal dry film thickness of Protecto 401. No lining shall take place when the substrate or ambient temperature is below 40 degrees Fahrenheit. The surface also must be dry and dust free. If flange pipe or fittings are included in the project, the lining shall not be used on the face of the flange.
   4) Coating of the Bell Sockets and Spigot Ends: Due to the tolerances involved, the gasket area and spigot end, up to 6 inches back from the end of the spigot end, must be coated with 6 mils nominal, 10 mils maximum, of Protecto Joint Compound. The Joint Compound shall be applied by brush to ensure coverage. Care should be taken that the Joint Compound is smooth without excess buildup in the gasket seat or on the spigot ends.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

Coating of the gasket seat and spigot ends shall be done after the application of the lining.

5) Number of Coats: The number of coats of lining material applied shall be as recommended by the lining manufacturer. However, in no case shall this material be applied above the dry thickness per coat recommended by the lining manufacturer in printed literature. The maximum or minimum time between coats shall be that time recommended by the lining material manufacturer. No material shall be used for lining which is not indefinitely recoatable with itself without roughening of the surface.

6) Touch-Up & Repair: Protecto Joint Compound shall be used for touch-up or repair in accordance with manufacturer's recommendations.

d. Inspection and Certification:

1) Inspection:

a) All ductile iron pipe and fitting linings shall be checked for thickness using a magnetic film thickness gauge. The thickness testing shall be done using the method outlined in SSPC-PA-2 Film Thickness Rating.

b) The interior lining of all pipe barrels and fittings shall be tested for pinholes with a non-destructive 2,500 volt test. Any defects found shall be repaired prior to shipment.

c) Each pipe joint and fitting shall be marked with the date of application of the lining system along with its numerical sequence of application on that date, with records maintained by the applicator.

2) Certification: The pipe or fitting manufacturer must supply a certificate attesting to the fact that the applicator met the requirements of this specification, and that the material was as specified.

e. Handling: Protecto 401 lined pipe and fittings must be handled only from the outside of the pipe and fittings. No forks, chains, straps, hooks, etc. shall be placed inside the pipe and fittings for the lifting, positioning, or laying.

D. The bell of each pipe shall have a tapered annular opening and a cast or machined retaining groove for the gasket. The gasket shall have a flared design so that maximum deflection will be provided. The plain spigot end of the pipe shall be beveled in order to simplify its entry into and centering within the bell and compression of the gasket.

E. Gaskets:

1. Gaskets shall be Styrene Butadiene Copolymer (SBR) or Ethylene Propylene Diene Monomer (EPDM) in accordance with ANSI A21.11/AWWA C111, latest revision made in the form of a solid ring to exact dimensions.

a. Push-on Joint Gaskets: The design of the gasket groove in the bell of the pipe and the design, hardness, and other properties of the gasket itself shall be such that the joint is liquid tight for all pressures from a vacuum to a maximum rating of 350 psi of internal liquid pressures.

1) Manufacturer / Model:

a) American Ductile Iron Pipe "Fastite,"

b) U.S. Pipe "Tyton," or

c) Approved equal.

b. Push-on Restrained Joint Gaskets: Restrained pipe and fittings are as shown on the Drawings. Retainer glands and similar devices will not be allowed unless otherwise noted or shown on the Drawings or approved by the Engineer. Push-

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

on joint restraint shall be incorporated in the design of the pipe bell and gasket. The restraint shall be provided by the wedging action developed between pairs of hardened high-strength, stainless steel elements spaced around the gasket. The push-on restrained joint shall be rated for 250 psi working pressure.

1) Manufacturer / Model:
   a) American Ductile Iron Pipe "Fast-Grip" (for pipe sizes 24-inch and less),
   b) U.S. Pipe "Field Lok" Gaskets (for pipe sizes 24-inch and less),
   c) American Ductile Iron Pipe "Flex-Ring" (for pipe sizes 30 and 36 inch),
   d) American Ductile Iron Pipe "Lok-Ring" (for pipe sizes greater than 46 inches),
   e) U.S. Pipe "TR Flex" (for pipe sizes 24-inch and larger), or
   f) Approved equal.

2. Lubricant: Lubricant shall be furnished with each order to provide for the proper installation of the pipe supplied with said order. This lubricant shall be nontoxic, impart no taste or smell to the water, and have no harmful effect on the rubber gasket. It shall have a consistency that will allow it to be easily applied to the pipe in either hot or cold weather and that will enable it to adhere to either wet or dry pipe.

F. Welded-on Outlets:

1. Welded-on outlets shall be limited to branch outlets having a nominal diameter less than 70 percent of the nominal diameter of the main line pipe or 30-inch whichever is smaller as shown in the following table.

Main Line	**Branch Outlet**
Nominal Diameter	**Nominal Diameter**
10 inch	6 inch
12 inch	8 inch
14 inch	8 inch
16 inch	10 inch
18 inch	12 inch
20 inch	14 inch
24 inch	16 inch
30 inch	20 inch
36 inch	24 inch
42 inch	30 inch
48 inch	30 inch
54 inch	30 inch

2. Parent pipe and branch outlet candidate pipe shall be centrifugally cast ductile iron designed in accordance with ANSI A21.50/AWWA C150 and manufactured in accordance with ANSI A21.51/AWWA C151. Minimum classes shall be: for sizes 4-inch through 54-inch, Special thickness Class 53; for sizes 60-inch through 64-inch, Pressure Class 350.
3. Welded-on outlets may be provided as a radial tee outlet, tangential outlet, or lateral outlet fabricated at a specific angle to the main line pipe in 1 degree increments between 45- and 90-degrees from the axis of the main line pipe as shown on the Drawings.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

4. All welded-on outlets shall be rated for a working pressure of 250 psi and must have a minimum safety factor of 2.0 based on proof of design hydrostatic test results.
5. The joints on welded-on branch shall meet, where applicable, the requirements of ANSI A21.11/AWWA C111 and/or ANSI A21.15/AWWA C115. The joint materials (glands, gaskets, and studs) shall be furnished where applicable.
6. Weldment for welded-on outlets shall be based on the method described in Section VIII of the ASME Unfired Pressure Vessel Code. Reinforcing welds shall be placed using Ni-Rod 55 cored wire or Ni-Rod 55 electrodes manufactured by INCO Alloys (or an electrode with equivalent performance properties). Carbon Steel electrodes are not acceptable.
7. Prior to the application of any coating or lining in the outlet area all weldments for branch outlets to be supplied on this project shall be subjected to an air pressure test of at least 15 psi. Air leakage is not acceptable. Any leakage shall be detected by applying an appropriate soapy water solution to the entire exterior surface of the weldment and adjoining pipe edges or by immersing the entire area in a vessel of water and visually inspecting the weld surface for the presence of air bubbles. Any weldment that shows signs of visible leakage shall be repaired and retested in accordance with the manufacturer's written procedures.
8. Welded-on outlets shall be fabricated by the pipe manufacturer at the same facility where the pipe is produced. The pipe manufacturer shall have a minimum of 5 years of experience in the fabrication and testing of outlets of similar size and configuration.
9. The manufacturer shall have a fully documented welding quality assurance system and maintain resident quality assurance records based on ANSI/AWS D11.2, the Guide for Welding Iron Castings. The manufacturer shall maintain appropriate welding procedure specifications (WPS), procedure qualification (PQR), and welder performance qualification test (WPQR) records as well as appropriate air test logs documenting air leakage tests.

G. Manufacturer:
1. American Ductile Iron Pipe,
2. Griffin Pipe Products,
3. McWane,
4. U.S. Pipe, or
5. Approved equal.

2.2 DUCTILE IRON FITTINGS

A. Standard and special fittings shall be Pressure Class 350 ductile iron. Use standard mechanical joint fittings or anchoring tees at hydrant locations. All fittings shall conform to the specifications of ANSI A21.10/AWWA C110 (Full Body) or ANSI A21.53/AWWA C153 (Compact), latest revisions.

B. All buried fittings shall be push-on or mechanical joint. Non-buried fittings shall be flanged unless otherwise shown on Drawings or directed by the Engineer. Where flanged pipe is shown, no substitution of a Uni-Flange type joint will be used without prior approval of the Engineer. Where push-on joint fittings are used, the fittings must be rodded to an anchor (i.e. dead-man, valve, etc.), have a mechanical joint fitting restraining device, or push-on restrained joint gasket.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

C. Coatings and Lining:
   1. Fittings shall be coated with an asphaltic coating approximately 1 mil thick in accordance with ANSI A21.51/AWWA C151.
   2. Fittings shall be lined with Protecto 401 lining. The lining shall be in accordance with 2.1.C.2 of this specification section.

D. Manufacturer:
   1. Tyler/Union,
   2. American Ductile Iron pipe, or
   3. Approved equal.

2.3 DUCTILE IRON FLANGED PIPE

A. Flanged pipe shall meet the requirements of ductile iron pipe and fittings, as specified herein, unless otherwise specified.

B. All ductile iron flanged pipe shall comply with ANSI A21.15/AWWA C115, latest revision. The pipe barrel shall be manufactured in accordance with ANSI A21.51/AWWA C151, latest revision. To insure accountability, all flanged pipe shall be fabricated at the factory by the barrel manufacturer. All flanges (unless otherwise indicated or required) shall be faced and drilled as follows:
   1. Ductile Iron: Working pressure less than 150 psi - ANSI B16.1, 125 pound.
   2. Ductile Iron: Working pressure greater than 150 psi - ANSI B16.1, 250 pound.
   3. Steel: Working pressure less than 260 psi - ANSI B16.5, 150 pound.
   4. Steel: Working pressure greater than 260 psi - ANSI B16.5, 300 pound.

C. Provide a flanged pipe gasket for each joint made of Styrene Butadiene Copolymer (SBR) or Ethylene Propylene Diene Monomer (EPDM) which meet all the material requirements of ANSI A21.11/AWWA C111.

D. Gaskets for flanged pipe with an operating pressure greater than 160 psi shall be Toruseal Flange Gasket as manufactured by American Cast Iron Pipe Company, American Ductile Iron Pipe Division, or approved equal.

E. Manufacturer:
   1. U.S. Pipe,
   2. American Ductile Iron Pipe, or
   3. Approved equal.

2.4 MECHANICAL JOINT FITTING RESTRAINT DEVICES

A. Ductile Iron Pipe Restraint Devices:
   1. Restraint devices for nominal pipe sizes 3 inch through 48 inch shall consist of multiple gripping wedges incorporated into a follower gland meeting the applicable requirements of ANSI/AWWA C110/A21.10. Restraint device shall have torque limiting twist-off nuts.
   2. Restraint devices shall have a working pressure rating of 350 psi for 3 through16 inch and 250 psi for 18 through 48 inch. Ratings are for water pressure and must include a minimum safety factor of 2 to 1 in all sizes.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3. Gland body, wedges and wedge actuating components shall be cast from grade 65-45-12 ductile iron material in accordance with ASTM A536.
4. Manufacturer / Model:
   a. EBAA Iron Inc. Megalug Series 1100, or
   b. Approved equal.

B. Plain End to Plain End Pipe Restraint Device:
1. Joint restraint to prevent axial separation shall be incorporated into the design of the sleeve or coupling used to connect two plain ends of same or dissimilar materials, such as ductile iron pipe, steel pipe, and or high density polyethylene (HDPE) pipe.
2. To prevent movement causing fitting to slide or rotate, internal pipe wall stiffeners must be used. The stiffeners for HDPE must be sized to encompass the entire bearing length of the restraint devices.
3. Restraint devices shall consist of multiple gripping wedges incorporated into a follower gland. Restraint device shall have torque limiting twist-off nuts.
4. The coupling sleeve shall be coated internally with a minimum of 15mils of fusion bonded epoxy conforming to the applicable requirements of ANSI/AWWA C213.
5. Ductile Iron components shall meet or exceed the requirements of ASTM A536.
6. The restrained joining system shall meet the applicable requirements of AWWA C219, ANSI/AWWA C111/A21.11, and ASTM D2000.
7. Manufacturer / Model:
   a. EBAA Iron, Inc. Series 3800, or
   b. Approved equal.

2.5 FLANGED COUPLING ADAPTERS

A. Flanged coupling adapters shall be used to connect plain end pipe to flanged fittings, meters, valves, or equipment as shown on the Drawings shall be rated for 200 psi working pressure unless indicated otherwise.

B. Materials of Construction:

Body	Steel	ASTM A53
Flange		
3” thru 5” Pipe		ANSI 150 lb flat face
6” Pipe and above		AWWA C207 Class D, ANSI 150 lb drilling
Follower		
3” thru 12” Pipe	Ductile Iron	ASTM A536
14” Pipe and above	Heavy Rolled Steel	AISI C1018
Gasket		Grade 30
Bolts and Nuts	304 Stainless Steel	
Interior Coating	Fusion Bonded Epoxy	
Exterior Coating	2 Coats of Rust Inhibiting Synthetic Resin or Asphaltum Enamel	

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

C. Manufacturer / Model
   1. Smith-Blair Model 913 Steel Restrained Flanged Coupling Adapter with Optional Anchor Studs, or
   2. Approved equal.

2.6 FLEXIBLE EXPANSION JOINT

A. Flexible expansion joints shall be installed in the locations indicated on the Drawings. Flexible expansion joints shall be cast from grade 65-45-12 ductile iron conforming to the material requirements of ASTM A536 and ANSI/AWWA C153/A21.53.

B. Each flexible expansion joint shall be pressure tested at the factory against its own restraint to a minimum of 350 psi (250 psi for 30" diameter and larger.) A minimum 2:1 safety factor shall apply.

C. Each flexible expansion joint shall consist of an expansion joint designed and cast as an integral part of a ball and socket type flexible joint, having a minimum per ball deflection of: 20 degrees, 3 inch – 12 inch; 15 degrees, 14 inch – 36 inch; 12 degrees, 48 inch and 4-inches minimum expansion. Additional expansion sleeves shall be available and easily added or removed at the factory or in the field. Both standardized mechanical joint and flange end connections shall be available.

D. All internal surfaces (wetted parts) shall be lined with a minimum of 15 mils of fusion bonded epoxy conforming to the applicable requirements of ANSI/AWWA C213. Sealing gaskets shall be constructed of EPDM. The coating and gaskets shall meet ANSI/NSF-61.

E. All external surfaces shall be coated with a catalyzed coal tar epoxy conforming to the material requirements of AWWA C210. Appropriately sized polyethylene sleeves, meeting ANSI/AWWA C105/A21.5, shall be included for direct buried applications.

F. Manufacturer / Model:
   1. EBAA Iron, Inc. FLEX-TEND, or
   2. Approved equal.

2.7 COMPRESSION COUPLINGS

A. When dissimilar pipe materials like PVC and concrete pipe are joined, use compression couplings that are resistant to the corrosive action of soils and sewage and that will provide a permanent watertight joint. The compression couplings shall be of natural or synthetic rubber or rubber-like material and shall comply with the requirements and test methods specified in Table 2 of ASTM C425. The coupling shall meet the leak requirements specified in ASTM C425, and the bands for attaching the couplings to the dissimilar pipes shall be of stainless steel meeting ASTM A167 or A240. Each coupling shall bear the manufacturer's identifying mark and an indication of its size. Compression couplings will not be allowed in the new sewer laterals (main line) without prior permission from the Engineer.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2.8 LINE MARKERS

A. Markers shall be single piece design, constructed of durable, UV resistant, composite material, and have a pointed end for ease of installation. The marker shall have a constant flat "T" cross-sectional design and be 3.75 inch in width and of such length to provide a minimum height above the ground surface of 44 inches and a minimum embedment depth of 18 inches. The marker shall resist displacement from wind and vehicle impact forces. The marker shall be free of burns, discoloration, cracks, bulges, or other objectionable marks. A line shall be stamped horizontally across the front of the marker to indicate proper burial depth.

B. The marker shall be pigmented throughout the entire cross-section so as to produce a uniform color which is an integral part of the material. The marker shall be colored green.

C. Line markers shall be labeled with the lettering "CAUTION SEWER LINE" with the Owners name and telephone number written below the lettering.

D. Manufacturer / Model:
   1. Carsonite International, Early Branch, SC Model CUM 375 or
   2. Approved equal.

2.9 DETECTION WIRE

A. Detection wire shall be UL approved, 14 AWG, type THHN solid copper. The wire shall be color coded green in accordance with APWA National Color Code.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Refer to Division 31 Section "Site Excavation, Backfilling, and Compaction" for excavating, trenching, and backfilling.

3.2 EXCAVATION FOR GRAVITY SEWERS

A. Unclassified excavation for pipelines shall consist of the excavation necessary for the construction of sewer lines and their appurtenances (including manholes, collars, concrete saddles, and pipe protection) that are called for by the drawings. It shall include clearing and grubbing where necessary, backfilling and tamping pipe trenches and around structures, and disposing of waste materials, all of which shall conform to the applicable provisions set forth elsewhere in these specifications.

B. The Contractor may, if he chooses, use a motor powered trenching machine. If he does, however, he shall be fully responsible for the preservation or repair of existing utility service connections.

C. Unless the construction of lines by tunneling or boring is called for by the drawings or specifically authorized by the Engineer, make excavation for pipelines in open cut and true to

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

the lines and grades shown on the drawings or established by the Engineer on the ground. Cut the banks of trenches between vertical parallel planes equidistant from the pipe centerline. The horizontal distance between the vertical planes (or, if sheeting is used, between the inside faces of that sheeting) shall vary with the size of the pipe to be installed, but shall not be more than the distance determined by the following formula: 4/3d + 15 inches, where "d" represents the internal diameter of the pipe in inches. When approved in writing by the Engineer, the banks of trenches from the ground surface down to a depth not closer than 1 foot above the top of the pipe may be excavated to non-vertical and nonparallel planes, provided the excavation below that depth is made with vertical and parallel sides equidistant from the pipe centerline in accordance with the formula given above. Any cut made in excess of the formula 4/3d + 15 inches shall be at the expense of the Contractor and may be cause for the Engineer to require that stronger pipe and/or a higher class of bedding be used at no cost to the Owner.

D. For all pipes provide a minimum 6 inches of No. 57 KYTC crushed stone for bedding.

E. Do not excavate pipe trenches more than 400 feet ahead of the pipe laying, and not more than 400 feet of open ditch shall be left behind the pipe laying, and perform all work so as to cause the least possible inconvenience to the public. Construct temporary bridges or crossing when and where the Engineer deems necessary to maintain vehicular or pedestrian traffic.

F. In all cases where materials are deposited along open trenches, place them so that in the event of rain no damage will result to the work and/or to adjacent property.

G. Refer to the Section regarding excavation for sheeting, shoring and bracing requirements.

3.3 PIPE LAYING

A. Two weeks prior to the commencement of trench excavation, the Contractor shall prepare and submit to the Engineer for review four (4) copies of detailed Cut Sheets showing the beginning and ending manholes; the distance between manholes; the grade, size and type of line; the depth of cut; etc. All expense for the preparation of Cut Sheets on minimum 50 foot centers including abrupt grade changes such as ditches shall be borne by the Contractor and be included in the unit price bid per foot of pipe.
   1. Cut Sheets must be reviewed and approved by the Engineer in writing before trenching operations may be permitted. It shall be the Contractor's responsibility to prepare Cut Sheets in advance of his anticipated trenching schedule.
   2. Minimum cover in roadways and other traffic-bearing areas is 48 inches. In non-traffic areas, the minimum cover is 30 inches.

B. Lay no pipe except in the presence of the Resident Project Representative.

C. Before placing sewer pipe in position in the trench, carefully prepare the bottom and sides of the trench, and install any necessary bracing and sheeting as required in this Specification.

D. Wherever necessary to provide satisfactory bearing surface, place concrete cradles as shown on the drawings or as directed by the Engineer. Cradles shall be of concrete and conform to the dimensions shown on the drawings. Concrete placed outside the dimensions shown shall be at the Contractor's expense.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

E. Tightly stretch a mason's line or wire above ground level, parallel to and directly above the axis of the pipe to be installed, supporting this line at intervals of no more than 50 feet for sewers being laid on a grade of 2 percent or more and of no more than 25 feet for grades of less than 2 percent. Determine the exact line and grade for each section of pipe by measuring down from this line to the invert of the pipe in place, and accurately place each pipe to the exact line and grade called for on the drawings. Furnish all labor and materials necessary for erecting batter-boards.

F. Lasers may be used after the type and procedures are approved by the Engineer. When lasers are used, set reference points for both line and grade at each manhole. Where grades are 0.6 percent or less, check the elevation of the beam each 100 foot with an offset point or engineer's level.

G. Do not allow water to run or stand in the trench while pipe laying is in progress or before the trench has been backfilled. Do not at any time open up more trench than the available pumping facilities are able to dewater.

H. Correct trench bottoms found to be unsuitable for foundations after pipe laying operations have started, bringing them to exact line and grade with crushed stone as necessary.

I. Carefully inspect each piece of pipe and special fitting before it is placed, and lay no defective pipe in the trench. Pipe laying shall proceed upgrade, starting at the lower end of the grade and with the bells upgrade. When pipe laying is not in progress, keep the ends of the pipe tightly closed with an approved temporary plug.

J. Bell holes shall be large enough to allow ample room for the pipe joints to be properly made. Cut out bell holes no more than two joints ahead of pipe laying. Carefully grade bottom of the trench between bell holes so each pipe barrel rests on a solid foundation for its entire length. Lay each pipe joint so as to form a close concentric joint with adjoining pipe and to avoid sudden offsets or inequalities in the flow line.

K. Before constructing or placing any joints, demonstrate to the Engineer, by completing at least one sample joint, that the methods to be used conform to the specifications and will provide a watertight joint and further that the workmen to be involved in this phase of work are thoroughly familiar and experienced with the type of joint proposed.
   1. No other type of joint may be used unless authorized in writing by the Engineer.

L. Install tee branches in sewer lines to serve properly each lot facing or abutting on the street or alley in which sewer is being laid at such other locations as may be designated by the Engineer. If tee branches are not to be used immediately, close them with approved stoppers that are held in place to prevent infiltration and withstand all test requirements.

M. For all tees that are plugged and laid in rock, blast a minimum of six linear feet of ditch line in the direction and to the approximate grade of the future lateral as directed by the Engineer, but do not excavate the material. This shall be done at no extra cost to the Owner. Furnish the Engineer with a record of the exact location of each tee installed.

N. If the work consists of constructing a new sewer to replace an existing one, connect existing service lines to the new line.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

O. New service laterals shall conform to the standard drawings.

P. Jointing:
   1. Clean ends of pipe, bell interior, and coupling components before jointing.
   2. Apply joint lubricant to pipe ends, bell interior, and elastomeric seals of coupling. Use only lubricants approved by the pipe manufacturer.
   3. Use suitable equipment and end protection to push or pull the pipes and/or couplings together. Do not exceed forces recommended by the pipe and coupling manufacturers.
   4. Join pipes in straight alignment then, if allowed, defect the pipe to the required angle. Deflection shall not exceed 3 degrees unless otherwise noted or the manufacturers recommended deflection.
   5. Join dissimilar pipe by using suitable compression couplings. If compression couplings are not available, make jointing with a special fabricated coupling approved by the Engineer.

Q. As the work progresses, thoroughly clean the interior of the pipe in place. After each line of pipe has been laid, carefully inspect it, and remove all earth, trash, rags, and other foreign matter from its interior.

R. After the joints have been completed, they shall be inspected, tested, and accepted by the Engineer before being covered. The pipe shall meet the test requirements for water-tightness; immediately repair any leak or defect discovered at any time after completion of the work. Any pipe that has been disturbed after joints were formed shall be taken up, the joints cleaned and remade, and the pipe re-laid at the Contractor's expense. Carefully protect all pipes in place from damage until backfilling operations are completed.

S. Do not begin the backfilling of trenches until the pipe in place has been inspected and approved by the Engineer.

T. Line Separation:
   1. Lay sewers at least 10 foot horizontally from any existing or proposed water main. If this is not practical, the sewer may be laid closer than 10 foot to a water main provided it is laid in a separate trench and the elevation of the top of the sewer is at least 18 inch below the bottom of the water main.
   2. Where a sewer crosses under water mains, the top of the sewer shall be at least 18 inch below the bottom of the water main. If the elevation of the sewer cannot be varied to meet the above requirements, relocate the water main to provide this separation, or else reconstruct it with mechanical joint ductile iron pipe for a distance of 10 foot on each side of the sewer with a full joint of the water main centered over the sewer.
   3. If it is impossible to obtain proper horizontal and vertical separation as stipulated above, construct both the water main and the sewer of mechanical joint ductile iron pipe, and pressure test each.
      a. Pipe shall be in accordance with paragraph 2.1 of this section with the exception that it be mechanical joint in lieu of bell and spigot.
      b. Sewer pipe shall be tested in place for a minimum of 2 hours without leakage prior to backfilling.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

c. The Engineer must approve the construction method to be used whenever the minimum 10-feet horizontal separation and/or 18-inch vertical separation is not possible.

U. Make connections to all existing sewer lines as shown on the drawings or as directed by the Engineer. Make connections either by removing a section of the sewer from the existing line and inserting a wye or tee branch of the proper size or by constructing a manhole, junction box, regulator chamber, or other structure as shown on the drawings.

V. Make connections to existing manholes or inlets by core drilling a hole in the wall of the existing structure, installing a Kor-N-Seal connector, inserting a length of sewer pipe into the hole. Shape or reshape the bottom of manholes as necessary to fit the invert of the sewer pipe.

W. Provide concrete protection or concrete cap as shown on the drawings for pipe sewers that, when completed, have less than 2.5 feet of covering in non-traffic areas and 4 feet of cover in traffic areas. If such protection is not shown on the drawings, place it in accordance with the typical section shown.

X. Carefully protect from damage all existing sewers, water lines, gas lines, sidewalks, curbs, gutters, pavements, electrical lines, and other utilities or structures in the vicinity of the work at all times. If it is necessary to repair, remove, and/or replace any such utility or structure in order to complete the work properly, do so in compliance with the provisions set forth in other section of these specifications or as required by the appropriate utility. Any such work shall be considered incidental to the construction of pipe sewers, and no additional payment will be allowed therefor.

1. Water service connections will be repaired or replaced by the Contractor at his expense as an incidental part of the work.
2. Service or house connections to existing sewers that are damaged or removed shall be repaired or replaced by the Contractor at his own expense as an incidental part of the work.

3.4 BACKFILLING

A. Begin backfilling after the line construction is completed, inspected, and approved by the Engineer.

1. Ductile Iron Pipe:
   a. On each side of the line, from the bottom of barrel to the top of the pipe, the backfill material shall consist of No. 57 (KYTC) stone.
   b. From the top of the pipe to one foot above the crown the backfill material shall be selected backfill consisting of either fine, loose earth like sandy soil or loam or of granular material that is free from clods, vegetable matter, debris, stone, and/or other objectionable materials and that has a size of no more than two inches. Place this backfill simultaneously on either side of the pipe in even layers that before compaction are no more than six inches deep.
   c. Thoroughly and completely tamp each layer into place before placing additional layers.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. From one foot above the pipe upward, the backfill material may contain broken stones that make up approximately 3/4 of the backfill's total volume, However, if this type of backfill is used, there must be enough spalls and earth materials to fill all voids completely. The maximum dimension of individual stones in such backfill shall not exceed six inches, and the backfill material shall be placed and spread in even layers not more than 12 inches deep. At locations beneath or closely adjacent to pavement or at locations of improvements subject to damage by displacement, the backfill shall be entirely No. 68 stone. Tamp and thoroughly compact the backfill in layers that, before compaction, are six inches deep. Contractor shall demonstrate that backfill material is compacted to 95 percent of optimum density as defined by ASTM D698 (Standard Proctor). In other areas, the backfill for the upper portion of the trenches may be placed without tamping but shall be compacted to a density equivalent to that of adjacent earth material as determined by laboratory tests. Use special care to prevent the operation of backfilling equipment from causing any damage to the pipe.

C. For all non-metallic piping installations, install continuous underground detection wire. Affix wire to top of pipe prior to backfilling. Wire shall be stripped and tied to valves for continuity.
   1. Where two sections of wire connect a 12 inch minimum twisted overlap is required with adequate bare wire connection for continuity. The bare wire connection shall be suitably coated to protect the wire from corrosion.
   2. The copper wire shall extend up into all valve boxes so it is accessible for connection to locating equipment.
   3. At uncased road crossings the Contractor shall install the copper wire onto the top of the plastic pipe.

D. If earth material for backfill is, in the opinion of the Engineer, too dry to allow thorough compaction, add enough water so that the backfill can be properly compacted. Do not place earth material that the Engineer considers too wet or otherwise unsuitable.

E. Wherever excavation has been made within easements across private property, the top one foot of backfill material shall consist of fine loose earth free from large clods, vegetable matter, debris, stone, and/or other objectionable materials. Topsoil shall be in accordance with the requirements of this Specification.

F. Wherever trenches have been cut across or along existing pavement, temporarily pave the backfill of such trenches by placing Type A, Grade D, crushed stone as the top 12 inches of the backfill. Maintain this temporary pavement either until the permanent pavement is restored or until the project is accepted by the Owner.

G. Conduct backfilling around manholes, inlets, outfalls, and/or structures in the same manner as specified above for pipelines except that even greater care is necessary to prevent damage to the utility structure.

H. Wherever pipes have diameters of 15 inches or less, do not use power operated tampers to tamp that portion of the backfill around the pipe within one foot above the pipe.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

I. Perform backfilling so as not to disturb or injure any pipe and/or structure against which the backfill is being placed. If any pipe or structure is damaged and/or displaced during backfilling, open up the backfill and make whatever repairs are necessary.

J. Backfilling and clean-up operations shall closely follow pipe laying; failure to comply with this provision will result in the Engineer's requiring that the Contractor's other activities be suspended until backfilling and clean-up operations catch up with pipe laying.

K. Install line markers directly above pipeline alignment at intervals of 1,000 feet where indicated on the Drawings. Line markers shall be installed after final clean-up is completed.

3.5 TESTING OF GRAVITY SEWERS

A. Visual Tests:
   1. Upon completion of the construction or earlier if the Engineer deems advisable, the Engineer will make a visual inspection of the sewer and construction site. Immediately repair all leaks and defects found by such inspection.
   2. In addition to general cleanup and leakage, the following standards shall be used to determine failure or defects of this project.
      a. Sewers shall be built so as to remain true to line and grade. The inclining grade of the bottom of the sewer after completion shall be such that, after flooding, the flood water drains off so that no remaining puddle of water is deeper than 1/2 inch on pipe 36 inch internal diameter or smaller and 3/4 inch on pipe larger than 36 inch internal diameter. Any section of pipe that does not comply with the specifications at any time previous to final acceptance of the work shall be replaced or re-laid at the Contractor's expense.
      b. The Contractor will be held strictly responsible that all parts of the work bear the load of the backfill. If cracks 1/100 inch develop in the pipe within one year from the date of final acceptance of the work, the Contractor will be required to replace, at his expense, all such cracked pipe. To this end, the Contractor is advised to purchase pipe under a guarantee from the manufacturer, guaranteeing proper service of sewer pipe under conditions established by the drawings, specifications, and local conditions at the site of the work.

B. Air Testing for Sewers 21 Inches and Smaller: Perform low pressure air testing as follows:
   1. Furnish all equipment, facilities, and personnel necessary to conduct the test. The test shall be observed by a representative of the Owner.
   2. Make the air test after all services have been installed and backfilling has been completed and compacted.
   3. Perform the first series of air tests after 2,000 LF but before 4,000 LF of sewer has been laid. The purpose of this first series of tests is to assure both the Contractor and the Owner that the materials and method of installation meet the intent of these specifications. Conduct the remainder of the tests after approximately each 10,000 LF has been laid.
   4. Plug all tees and ends of sewer services with flexible joint plugs or caps securely fastened to withstand the internal test pressures. Such plugs or caps shall be readily removable, and their removal shall provide a socket suitable for making a flexible jointed lateral connection or extension.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

5. Prior to testing, check the pipe to see that it is clean. If not, clean it by passing a full-gage squeegee through the pipe. It shall be the Contractor's responsibility to have the pipe cleaned.
6. Immediately following this check or cleaning, test the pipe installation with low pressure air. Supply the air slowly to the plugged pipe installation until the internal air pressure reaches 4.0 PSI more than the average back pressure of any ground water that may submerge the pipe. Allow at least three minutes for temperature stabilization.
7. The pipeline shall be considered acceptable when tested at an average pressure of 3.0 PSI more than the average back pressure of any ground water that may submerge the pipe, if the section under test does not lose air at a rate greater than that specified. Calculate the pressure drop as the number of seconds for the air pressure to drop from a stabilized pressure of 3.5 to 2.5 PSI more than the average back pressure of any ground water that may submerge the pipe. Calculate time as described in ASTM C828.
8. The requirements of this specification shall be considered satisfied if the time required in seconds for the pressure to decrease from 3.5 to 2.5 PSI more than the average back pressure of any ground water that may submerge the pipe is not less than that shown in the following table:

MINIMUM TEST TIME AND ALLOWABLE AIR LOSS VALUES

Pipe Size	Minimum Test Time in Seconds Per 100 LF	Allowable Air Loss in CFM
4 inch	25	2.0
6 inch	42	2.0
8 inch	72	2.0
10 inch	90	2.5
12 inch	108	3.0
15 inch	126	4.0
18 inch	144	5.0
21 inch	180	5.5

9. If the pipe installation fails to meet these requirements, the Contractor shall determine at his own expense the source or sources of leakage and repair or replace all defective materials or workmanship. The completed pipe installation shall meet the requirements of this test before being considered acceptable.
10. The recommended procedures for conducting acceptance tests are as follows:
    a. Clean pipe that is to be tested.
    b. Plug all pipe outlets with suitable test plugs, and brace each plug securely.
    c. Increase gage pressure in the test by the amount of ground water pressure at the crown of the pipe.
    d. Add air slowly to the portion of the pipe installation being tested until the internal air pressure is raised to 4.0 PSI more than the average back pressure above the crown of the pipe.
    e. After the above internal pressure is obtained, allow at least two minutes for air temperature to stabilize, adding only the amount of air required to maintain pressure.
    f. After two minutes, disconnect the air supply.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

g. When pressure decreases to 3.5 psig either by leaking down or by bleeding down with a release valve, start the stopwatch, and determine the time in seconds that is required for the internal air pressure to reach 2.5 psig. Compare this time interval as calculated above. If time is more than that calculated, the test shall be assumed to be acceptable.

11. Plugs used to close the sewer pipe for the air test must be securely braced to prevent the unintentional release of a plug, which can become a high velocity projectile. Locate gages, air piping manifolds, and valves at the top of the ground. No one shall be permitted to enter a manhole where a plugged pipe is under pressure. Four pounds air pressure (gage) develops a force against the plug in a 12 inch pipe of approximately 450 pounds. Provide a safety release device set to release at 10 PSI between air supply and the sewer under test.

C. Air Testing for Sewers Larger than 21 Inches:

1. Test each full segment of pipe for air tightness at 3.5 psig for the minimum dwell period specified. Seal pipe ends with suitable restrained closure. Pressurize the pipe with air at 3.5 psig and cut off the air source. Commence timing the dwell period specified. If the pressure falls below 3.0 psig within the test period the segment shall be rejected. Contractor shall make corrections at his own expense.
2. All other recommended procedures for conducting pressure testing as described in 3.04.B shall be followed.

MINIMUM TEST TIMES AND ALLOWABLE AIR LOSS VALUES (0.5 psig Pressure Drop)

Pipe Size	Minimum Test Time in Seconds (Minutes) per 100 LF	Allowable Air Loss in CFM
24 inch	216 (3.6)	6.0
27 inch	252 (4.2)	6.5
30 inch	288 (4.8)	7.0
36 inch	360 (6.0)	8.0
42 inch	438 (7.3)	9.0
48 inch	510 (8.5)	10.0

3. Air testing of pipes more than 30 inch in diameter shall not be performed unless necessary because of the difficulty of adequately blocking the plugs. Provide a safety release device set to release at 10 PSI between the air supply and the sewer under test.

D. Testing for Sewers Larger than 24 inches in Diameter:

1. The Contractor is responsible for providing all labor and equipment for testing.
2. The Contractor shall utilize an ultrasonic method to detect leaks. An ultrasonic transmitter shall be utilized in coordination with an ultrasonic detector. The detector converts ultrasonic signals and amplifies them for ease of detection.
3. The transmitter, when placed on the inside of the pipe, will seek out and penetrate holes in the pipe or joint. Scanning the detector along the outside of the pipe will allow the water to hear and pinpoint the spot of ultrasonic penetration.
4. When detecting leaks on buried lines, a metal rod shall be run down to the pipe and probe of the gun shall be touched to the rod. A leak will be detected by the sound of a running faucet. Proceed at 10- to 25-foot intervals to locate leaks.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

E. Infiltration Testing:
   1. Ground water above the pipe will reduce air loss. If the section of line under test shows significant infiltration, the Contractor, at no added compensation over the Contract price for the sewers, shall furnish, install and maintain a V-notch sharp crested weir in a wood frame tightly secured at the low end of each sewer lateral and at locations on the main sewers directed by the Engineer. Maximum allowable infiltration shall be 25 gallons per mile per inch of diameter of sewer per 24-hour day at any time. The joints shall be tight, and visible leakage in the joints or leakage in excess of that specified above shall be repaired at the Contractor's expense by any means found to be necessary.
   2. When infiltration is demonstrated to be within the allowable limits, the Contractor shall remove such weirs.
   3. Infiltration tests may be required for the complete line or any portion thereof. Failure of any part of the line to pass an infiltration test shall be sufficient reason to require additional work by the Contractor to reduce the amount of infiltration in such portion of the line tested.
   4. The passing of an infiltration test shall in no way relieve the Contractor of any responsibility to repair visible leaks found during the visual inspection.
   5. Infiltration testing shall be performed on sewers larger than 30 inches in diameter when the hydrostatic head outside the pipe exceeds the upstream manhole depth above the top of the pipe.

F. Exfiltration Testing:
   1. For sewers larger than 30 inches in diameter the sewer shall be tested by exfiltration when infiltration testing cannot be performed.
   2. The groundwater table must be maintained below the section of pipe being tested at all times.
   3. When exfiltration testing is employed, the sewer shall be subjected to a minimum of four feet of head, or up to the top of the previously tested manhole, whichever is lesser, above the crown of the pipe at the upstream manhole of the section being tested.
   4. Hold the water level constant for at least 30 minutes, adding water as necessary. Measure and record duration and quantity of water added.
   5. The maximum allowable exfiltration shall be 25 gallons per mile per inch of diameter of sewer per 24-hour day.
   6. If the pipe installation fails to meet the test requirements, the Contractor shall determine at his own expense the source or sources of leakage and repair or replace all defective materials or workmanship. The completed pipe installation shall meet the requirements of the test before being considered acceptable.

G. Repairs: Regardless of the outcome of any tests, repair any noticeable leak.

H. No additional payment will be made for testing gravity sewers and shall be merged into the cost of pipe.

I. Submit written testing records to the Engineer documenting the results of the tests for each section of sewer between manholes. The record shall show, at a minimum, sewer size, manhole numbers, sewer length, duration of test, quantity of water added (exfiltration test), measured infiltration/exfiltration rate, and pressure loss (low pressure air test).

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3.6 VISUAL INSPECTION OF MISCELLANEOUS MATERIALS

A. All material used on this project will be visually inspected by the Engineer at the site for conformance to the required specifications. When reasonable doubt exists that said material meets the specifications, the Engineer may require certified mill tests, samples, and/or tests by an independent laboratory or other suitable form of verification that the material meets the required specifications.

3.7 DEFLECTION TESTING FOR PVC, CCFRPM AND HDPE PIPE

A. Test deflection of the pipe by passing a 9-arm pin go/no-go mandrel sized to 95 percent of the pipe diameter of the actual Pipe used with the pipe in place and covered. Make this acceptance test after backfill consolidation has occurred. The Contractor shall provide the mandrel and conduct test in presence of the Engineer.

B. No additional payment will be made for mandrel testing and shall be merged into the cost of pipe.

3.8 CLEANUP

A. After completing each section of the sewer line, remove all debris, construction materials, and equipment from the site of the work, grade and smooth over the surface on both sides of the line, and leave the entire right-of-way in a clean, neat, and serviceable condition.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

B. Related Sections include the following:
1. Division 33 Section "Sanitary Sewers (Gravity)" for manhole connections to gravity sewer.

1.2 SUMMARY

A. The Work under this Section includes, but is not limited to, manholes with eccentric cones, unless otherwise approved by the Engineer.

B. Refer to other sections for items affecting manholes. Coordinate this work with that specified by other sections for timely execution.

1.3 SUBMITTALS

A. Shop drawings are required in accordance with Division 01 Section “Submittal Procedures”, for castings, plastic gaskets, manhole steps, resilient pipe connection, and precast manholes specified in this section.

B. Supply certified copies in duplicate for the inspection and acceptance reports of the testing laboratory to the Engineer before using the materials.

C. Submit a certificate from the manufacturer of the castings indicating that they meet all applicable requirements of these specifications.

1.4 QUALITY ASSURANCE

A. After delivery to the site, any materials that have been damaged in transit or are otherwise unsuitable for use in the work shall be rejected and removed from the site.

B. Manholes shall be wet cast type of high quality. Manholes shall be watertight.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect manholes against damage during shipping.

PART 2 - PRODUCTS

2.1 CONCRETE MASONRY

A. Reinforced, normal weight concrete, having a minimum 28 days compressive strength of 4000 PSI.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2.2 STEEL TRAFFIC GRADE ADJUSTMENT RING (FOR CASTING ADJUSTMENT)

A. Adjustment rings shall conform to ASTM A48, Class 30, material specifications. The adjustment ring shall be of a traffic design and no more than 2-inches in height. The extension ring shall be No. 2500 as manufactured by John Bouchard & Son, Company, or approved equal. Reinforced concrete adjustment rings shall also be allowed.

2.3 MORTAR

A. Composed of one part Portland cement and two parts sand (volumetric measure) thoroughly mixed in a tight box, with water added gradually and mixed continually until mortar has attained the proper consistency for use in the work; prepared only in such quantities as needed for immediate use; mortar mixed for more than 30 minutes, re-tempered, or previously set will not be allowed.

2.4 GRAY IRON CASTINGS

A. Cast iron conforming to the requirements of ASTM A48, Class 30; made accurately to the required dimensions; sound, smooth, clean, and free from blisters and other defects; not plugged or otherwise treated to remedy defects; machined so that covers rest securely in the frames with no rocking and are in contact with frame flanges for the entire perimeter of the contact surfaces; thoroughly cleaned subsequent to machining and, before rusting begins, painted with a bituminous coating so as to present a smooth finish; tough and tenacious when cold, but not tacky and with no tendency to scale; and with the actual weight in pounds stenciled or printed by the manufacturer on each casting in white paint.

2.5 STANDARD FRAME AND COVER

A. The standard frame and cover shall be traffic typed gray cast iron ASTM A48 - Latest Revision, with a 24-inch (minimum) diameter opening weighing not less than 360 pounds. The covers shall be the solid self- sealing type with no holes except watertight pick notches. The surface between the cover and frame shall fit smoothly without rocking and shall be thoroughly cleaned. The gray iron castings shall be painted with a bituminous coating.

B. Cover shall be of the solid indented type with the words "Sanitary Sewer" cast in raised letters thereon. Manhole frames and covers shall be John Bouchard & Sons Company, Model No. 1150; East Jordon Iron Works, Inc., Model No. V-1550; or approved equal.

2.6 WATERTIGHT MANHOLES FRAMES AND COVERS

A. The watertight manhole frames shall be set in the same manner prescribed for standard frames except special attention shall be paid to securing a watertight connection to the manhole barrel.

B. The watertight manhole frame and cover shall be a traffic type of grey cast iron ASTM A48 with a 24 inch diameter minimum clear opening weighing not less than 550 pounds and shall be of the two-cover design as shown on the Plans.

C. The surface cover shall be the solid type with no holes except watertight pick notches or a heavy lifting ring. The surface between this cover and frame shall fit without rocking. The

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

inner cover shall be of the solid type with no holes, shall have not less than two lifting handles and shall have a neoprene sealing gasket at last 3/8 inch diameter cross-section. The inner cover shall be mechanically sealed by means of a removable metal bar located over the inner cover with a centrally-located stainless steel tightening bolt. This bolt shall be fitted for a tee-handle or bent-handle for turning which shall be included with each cover. The bolt shall have Acme threads for durability. The inner cover shall have appropriate reinforcing ribs to prevent cracking or distortion when tightened. The inner cover shall have sufficient clearance to allow easy installation of the cover. Manhole frame and cover shall be John Bouchard & Sons Company, Model No. 1123 or approved equal.

2.7 MANHOLE JOINT SEALANT FOR PRECAST MANHOLES

A. Flexible sealant for joints in pre-cast manhole sections shall provide permanently flexible watertight joints, shall remain workable over wide temperature range and shall not shrink, harden or oxidize upon aging. Material shall be butyl resin sealant ConSeal CS-102 or CS-202 as manufactured by Concrete Sealants, Inc. of New Carlisle, Ohio, RUB'R-NEK L-T-M manufactured by K.T. Snyder Company, Inc. of Houston, Texas, or other approved equal.

2.8 MANHOLE STEPS

A. Manhole steps shall be made of copolymer polypropylene plastic meeting the latest revision of ASTM D2146, Type II, Grade 16906 and shall have a 1/2 inch diameter Grade 60 reinforcing rod meeting the latest revision of ASTM A615 through its center. Each step shall be 12 inches in width and capable of carrying a load of 1,000 pounds in the center of the step when projected 6 inches from the wall. Each step shall be equipped with non-skid grooves.

2.9 MANHOLE INVERTS

A. Manhole inverts shall be formed from 2,000 PSI concrete. Inverts for "Straight-through" manholes may be formed by laying the pipe straight through the manhole, pouring the concrete invert and then breaking out the top half of the pipe. Curved inverts shall be constructed of concrete and shall form a smooth even, half-pipe section. The inverts shall be constructed when the manhole is being built.

B. The bench or top portion of the invert shall slope to the flow line to prevent standing water.

C. Services within the manhole, higher than 2 foot above the manhole invert, shall be constructed of brick laid on edge and longitudinally with the invert channel. Inside face joints shall be not more than 1/4 inch thick. The brick shall smoothly transition to the manhole invert.

2.10 RESILIENT PIPE CONNECTIONS AT MANHOLES

A. Resilient pipe connectors shall be manufactured in accordance with ASTM C923 and shall provide a positive watertight joint and minimum of 10 degrees deflection in any direction. There shall be no water leakage through the connector when pipe is in its maximum deflected position. Connectors shall be manufactured of durable construction. Connectors shall be manufactured of durable rubber which offers superior resistance to water, sewage, oils, acid, ozone, weathering and aging. Conical type flexible boot of the proper size to match the OD of the connection pipes shall be clamped securely to the cut out in the manhole wall and to the

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

pipe by means of stainless steel clamps or bands. The void area between the pipe and the connector shall be sealed with an approved flexible gasket material. The flexible boot shall meet ASTM C443. Connectors shall be as manufactured by the KOR-N-SEAL Company of Milford, New Hampshire, Press-Boot by Press-Seal Gasket Corporation of Fort Wayne, Indiana, or approved equal.

B. Compression-type connectors cast integrally into the manhole wall shall be equivalent to the A-Lok Manhole Pipe Connector as manufactured by A-Lok Products, Inc. Compression-type connectors shall only be used when specifically called for on the drawings.

2.11 PRE-CAST CONCRETE MANHOLES

A. Precast manholes shall be constructed on a reinforced concrete foundation and shall be wet cast as modified herein. The bottom section of the manhole shall be precast integrally with the precast ring and shall be 4'-0" in diameter. All concrete used in connection with the construction of manholes shall be 4,000 PSI concrete. Wet cast precast manholes shall be manufactured by Carter Concrete Products of Boaz, Kentucky; Cloud, or approved equal.

B. The precast manhole manufacturer shall use the additive Xypex Concentrate Admix C-2000/C-1000 at the rate of 2-3 percent by weight of cement in the concrete mix for all manholes. The Xypex Concentrate Admix must be added to the concrete at the time of batching as recommended by the manufacturer Xypex Chemical Corporation, Richmond, British Columbia, Canada, local contact (615) 333-1000 or approved equal.

C. Precast concrete rings shall be constructed using standard forms and shall conform to ASTM C478 including steel reinforcement.

D. The precast sections shall be manufactured and installed in a manner so that there is no visible leakage in the manholes. The manhole section shall be manufactured in lengths such that a finished manhole will have the least possible number of joints. One section less than four feet in length will be allowed per manhole and that being the section required to bring the manhole to grade. Holes penetrating completely through the precast manhole wall for lifting will not be allowed. The precast rings shall be of the tongue and groove design sealed watertight, and the joint shall be grouted smooth on the inside of the manhole so that no crack is visible. A resilient pipe connection shall be utilized in the sewer line to manhole connection, unless specifically noted on the drawings.

E. The manhole sidewall shall be adjusted with either steel or concrete grade adjustment rings as required to bring the casting to grade.

F. The exterior manhole walls shall receive two coats of asphaltic damproofing material conforming to ASTM D1227.

G. Manholes connected to force mains or designated on the Drawings shall be protected from hydrogen sulfide gas by the following:
   1. Concrete surfaces shall cure for a minimum of 28 days before applying liquid epoxy.
   2. Interior surface of manholes shall be clean and dry and all oil and grease shall be removed. Interior surfaces shall be cleaned using brush-off blast cleaning conforming to ASTM D429.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3. Apply manhole lining systems (minimum 250 mil thickness) in accordance with manufacturer's specifications. Approved manhole lining systems include:
   a. SpectraShield by CCI Spectrum, Inc.
   b. SPRAYWALL by Sprayroq.
   c. Approved equal.

PART 3 - EXECUTION

3.1 PREPARATION

A. Dewater sufficiently to maintain the ground water level at or below the bottom of the manhole foundation prior to and during placement of the foundation.

B. Obtain an adequate foundation for all manhole structures by removing and replacing unsuitable material with KYTC No. 57 or No. 67 crushed stone or by such other means as provided for foundation preparation of the connected sewers or as approved by the Engineer. Wherever water is encountered at the site, place all cast in place bases or monolithic structures on a one-piece waterproof membrane to prevent any movement of water into the fresh concrete.

3.2 INSTALLATION

A. For precast manholes, carefully place the base section upon the prepared surface so that it is fully and uniformly supported in true alignment; make sure that all entering pipes can be inserted at proper grade. Then place the concrete foundation and invert under and upon this base section as shown in the standard drawings. A base section with monolithic foundation (bottom) may be used when approved by the Engineer.

B. Thoroughly wet and then completely fill all lift holes and all interior joints between precast elements with non-shrink grout. Smooth them inside to ensure water tightness.

C. A continuous butyl resin gasket shall be placed on both the tongue and groove of each joint of the precast manhole as shown on the Drawings.

D. Carefully set the cast iron frame for the cover at the required elevation. The frame shall be secured to the concrete manhole using four 5/8-inch diameter stainless steel anchor bolts and stainless steel washers. The frame shall be sealed against the concrete manhole using a continuous flexible butyl resin gasket placed inside the bolt hole ring. Wherever manholes are constructed in paved areas, tilt the top surface of the frame and cover so as to conform to the exact slope, crown, and grade of the existing adjacent pavement. Existing frames and covers reused for elevation adjustment shall be thoroughly cleaned before reinstallation.

E. Manhole inverts shall be constructed of concrete or mortared masonry fill and may, at the Contractor's option, be covered with cement mortar to the approximate cross section of the sewers connected to them. Make any necessary changes in cross sections gradually from side to side of the manhole; make changes in direction of flow of the sewers to a true curve of as large a radius as is permitted by the size of the manhole.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

F. Use flexible watertight manhole couplings on all pipes at connections to manholes. Connector shall meet the requirement of ASTM C923. Connector shall be supplied with external stainless steel pipe clamp. Connector shall be Kor-N-Seal or approved equal.

G. Where the difference in the invert elevation of two or more sewers intersecting in one manhole is 24 inch or more, construct a drop manhole. Drop manholes shall be similar in construction to standard manholes except that a drop connection of pipe and fittings of the proper sizes and materials shall be constructed outside the manhole and supported by 3,000 PSI concrete as indicated by the standard drawings.

H. Place backfill by hand around the manhole and to a distance of at least one pipe length into each trench, and tamp with selected material up to an elevation of 12 inch above the crown of all entering pipes. Continue backfilling in accordance with the requirements for trenching backfilling.

I. Vacuum Testing of New Manholes:
1. This test is only applicable to precast concrete manholes.
2. All lifting holes shall be filled and pointed with an approved non-shrinking mortar.
3. Manholes are to be tested immediately after assembly and before backfilling. No standing water shall be allowed in the manhole excavation which may affect the accuracy of the test.
4. All pipes and other openings into the manhole shall be suitably plugged in such a manner as to prevent displacement of the plugs while the vacuum is drawn.
5. Installation and operation of vacuum equipment and indicating devices shall be in accordance with equipment specifications and instructions provided by the manufacturer.
6. The test head shall be placed to include the manhole casting (frame).
7. A vacuum of 10 inches of mercury shall be drawn. The time for the vacuum to drop to 9 inches of mercury shall be recorded.
8. Acceptance for 4 foot diameter manholes shall be defined as when the time to drop to 9 inches of mercury conforms to the table below. Contractor shall keep a log of all tests which shall be submitted to the Engineer for approval.

Manholes Depth	Diameter	Time to Drop 1 Inch Hg
10 feet or less	4 feet	60 seconds
10.1 feet to 15 feet	4 feet	75 seconds
15.1 feet to 25 feet	4 feet	90 seconds

9. For manholes 5 feet in diameter, add an additional 15 seconds and for manholes 8 feet in diameter, add an additional 45 seconds to the time requirements for four foot diameter manholes.
10. If the manhole fails to test, necessary repairs shall be made and vacuum test repeated until the manhole passes the test.
11. If the manhole joint mastic or gasket is displaced during the vacuum test, the manhole shall be disassembled and the seal replaced.
12. No additional payment will be made for testing and cost shall be merged into cost of manholes.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3.3 ACCEPTANCE TEST FOR EXISTING MANHOLE GRADE ADJUSTMENT

A. After the manhole has been adjusted to the proper grade, the manhole shall be visually inspected by the Contractor in the presence of the Engineer's Representative. Any defects noted shall be corrected by the Contractor until the work is found satisfactory to the Engineer's Representative. In addition, at the Engineer's request, the Contractor may be required within one year to visually inspect the manholes that were adjusted. Any work that has become defective shall be redone by the Contractor at no additional expense to the Owner.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes storm drainage outside the building.

B. Related Sections include the following:
   1. Division 03 Section "Cast-in-Place Concrete" for concrete structures.
   2. Division 31 Section "Site Excavation, Backfilling, and Compaction".

1.3 DEFINITIONS

A. RCP: Reinforced concrete pipe.

B. PE: Polyethylene plastic.

1.4 SUBMITTALS

A. Shop Drawings: Include plans, elevations, details, and attachments for the following:
   1. Precast concrete manholes and other structures, including frames, covers, and grates.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect pipe, pipe fittings, and seals from dirt and damage.

B. Handle precast concrete manholes and other structures according to manufacturer's written instructions.

1.6 PROJECT CONDITIONS

A. Site Information: Perform site reconnaissance, research public utility records, and verify existing utility locations.

B. Locate existing structures and piping to be closed and abandoned.

C. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
   1. Notify Engineer and Owner not less than three days in advance of proposed utility interruptions.
   2. Do not proceed with utility interruptions without Engineer's written permission.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 2 - PRODUCTS

2.1 PIPES AND FITTINGS

A. Provide pipe and pipe fitting materials that are compatible with one another.

B. Corrugated PE Drainage Tubing and Fittings: AASHTO M 252, Type S, with smooth waterway for coupling joints.
   1. Silt-tight Couplings: PE sleeve with ASTM D 1056, Type 2, Class A, Grade 2 gasket material that mates with tube and fittings to form silttight joints.

C. Corrugated PE Pipe and Fittings: AASHTO M 294, Type S, with smooth waterway for coupling joints.
   1. Silttight Couplings: PE sleeve with ASTM D 1056, Type 2, Class A, Grade 2 gasket material that mates with pipe and fittings to form silttight joints.

D. Reinforced-Concrete Circular Pipe and Fittings: ASTM C 76(ASTM C 76M), Class III, Wall B, for gasketed joints.
   1. Gaskets: ASTM C 443(ASTM C 443M), rubber.

E. Reinforced-Concrete Arch Pipe: ASTM C 506(ASTM C 506M), Class IV, for banded joints.
   1. Sealing Bands: ASTM C 877(ASTM C 877M), Type I.

F. Reinforced-Concrete Elliptical Pipe: ASTM C 507(ASTM C 507M), Class IV, for banded joints.
   1. Pattern: Type HE, horizontal.
   2. Sealing Bands: ASTM C 877(ASTM C 877M), Type II.

2.2 STORM DRAINAGE STRUCTURES

A. Normal-Traffic Precast Concrete: ASTM C 478(ASTM C 478M), precast, reinforced concrete, of depth indicated, with provision for rubber gasketed joints.
   1. Dimensions: 48 inches (1200 mm) minimum, unless otherwise indicated.
   2. Base Section: 8-inch (200-mm) minimum thickness for floor slab and 4-inch (100-mm) minimum thickness for walls and base riser section, and having separate base slab or base section with integral floor.
   3. Riser Sections: 5-inch (125-mm) minimum thickness and lengths to provide depth indicated.
   4. Manhole Top Section: Eccentric-cone type, unless concentric-cone or flat-slab-top type is indicated. Top of cone of size that matches grade rings.
   5. Gaskets: ASTM C 443(ASTM C 443M), rubber, or as noted.
   6. Grade Rings: Include reinforced-concrete rings, of 9-inch (229-mm) maximum thickness, that match 24-inch-(610-mm-) diameter frame and cover. Brick may be used for grade rings.
   7. Steps: Fiberglass or polypropylene individual steps. Include width that allows worker to place both feet on one step and is designed to prevent lateral slippage off step. Cast or anchor into base, riser, and top section sidewalls with steps at 12- to 16-inch (300- to 400-mm) intervals. Omit steps for manholes less than 60 inches (1500 mm) deep.
   8. Pipe Connectors: ASTM C 923(ASTM C 923M), resilient, of size required, for each pipe connecting to base section.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Cast-in-Place Concrete: Construct of reinforced-concrete bottom, walls, and top; designed according to ASTM C 890 for A-16, heavy-traffic, structural loading; of depth, shape, dimensions, and appurtenances indicated.
   1. Grade Rings: Include reinforced-concrete rings, of 9-inch (229-mm) maximum total thickness, that match 24-inch-(610-mm-) diameter frame and cover. Brick may also be used for grade rings.
   2. Steps: Fiberglass or polypropylene individual steps. Include width that allows worker to place both feet on one step and is designed to prevent lateral slippage off step. Cast or anchor into sidewalls with steps at 12- to 16-inch (300- to 400-mm) intervals. Omit steps for manholes less than 60 inches (1500 mm) deep.

C. Manhole Frames, Grates, and Covers: ASTM A 48, Grade 60-40-18, gray-iron castings designed for heavy-duty service. Include 24-inch (610-mm) ID by 7- to 9-inch (178- to 229-mm) riser with 4-inch (100-mm) minimum width flange, and 26-inch-(660-mm-) diameter cover. Include indented top design with lettering "STORM SEWER" cast into cover.

D. Frames and Grates: ASTM A 48, Grade 60-40-18, gray iron designed for heavy-duty service. Include 24-inch (610-mm) ID by 7- to 9-inch (178- to 229-mm) riser with 4-inch (100-mm) minimum width flange, and 26-inch-(660-mm-) diameter flat grate with small square or short-slotted drainage openings.
   1. Grate Free Area: Approximately 50 percent, unless otherwise indicated.

2.3 STORMWATER INLETS

A. Area Inlets: Made with horizontal opening, of materials and dimensions according to utility standards when appropriate. Include heavy-duty frames and grates.

B. Curb Inlets: Made with vertical curb and horizontal gutter openings, of materials and dimensions according to utility standards when appropriate. Include heavy-duty frames and grates.

C. Frames and Grates: Heavy-duty frames and grates according to utility standards.

2.4 CONCRETE

A. Conform to the requirements of Division 03 Section "Cast-in-Place Concrete".

B. General: Cast-in-place concrete according to ACI 318, ACI 350R, and the following:
   1. Cement: ASTM C 150, Type II.
   2. Fine Aggregate: ASTM C 33, sand.
   3. Coarse Aggregate: ASTM C 33, crushed gravel.
   4. Water: Potable.

C. Portland cement Design Mix: 3000 psi minimum, with 0.45 maximum water-cementitious ratio.
   1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
   2. Reinforcement Bars: ASTM A 615/A 615M, Grade 60(Grade 420), deformed steel.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

D. Structure Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 3000 psi minimum, with 0.45 maximum water-cementitious ratio.
   1. Include channels and benches in manholes.
      a. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.
         1) Invert Slope: 1 percent minimum through manhole.
      b. Benches: Concrete, sloped to drain into channel.
         1) Slope: 8 percent minimum.
   2. Include channels in catch basins.
      a. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.
         1) Invert Slope: 1 percent minimum through catch basin.

E. Ballast and Pipe Supports: Portland cement design mix, 3000 psi (20.7 MPa) minimum, with 0.58 maximum water-cementitious ratio.
   1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
   2. Reinforcement Bars: ASTM A 615/A 615M, Grade 60(Grade 420), deformed steel.

2.5 CLEANOUTS

A. Gray-Iron Cleanouts: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug. Use units with top-loading classifications for heavy-duty applications.
   1. Pipe Fitting and Riser to Cleanout: ASTM A74, Service class, cast-iron soil pipe and fittings.

B. PVC Cleanouts: PVC body with PVC threaded plug. Include PVC pipe fitting and riser to cleanout of same material as piping.

2.6 TRENCH DRAINS

A. Gray-Iron Trench Drains: ASME A112.21.1M, 6-inch-(150-mm-) wide top surface, rectangular body with anchor flange or other anchoring device, and rectangular, secured grate. Include units of total lengths indicated and number of bottom outlets with inside calk or spigot connections, of sizes indicated. Use units with top-loading classifications according to the following applications:
   1. Medium Duty: In paved foot-traffic areas.
   2. Heavy Duty: In vehicle-traffic service areas.
   3. Extra-Heavy Duty: In roads.

2.7 PIPE OUTLETS

A. Head Walls: Precast reinforced concrete, with apron and tapered sides.

B. Riprap Apron: Broken, irregular size and shape, uniform graded stone.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Division 31 Section "Site Excavation, Backfilling, and Compaction".

3.2 PIPING APPLICATIONS

A. General: Include silt-tight joints, unless watertight joints are indicated.

B. Refer to Part 2 of this Section for detailed specifications for pipe and fitting products listed below. Use pipe, fittings, and joining methods according to applications indicated.

C. Gravity-Flow Piping: Use the following:
1. Reinforced-concrete circular pipe and fittings, gaskets, and gasketed joints. Do not use non-reinforced pipe.
2. Ductile-iron sewer pipe; standard-pattern, ductile-iron fittings; gaskets; and gasketed joints.
3. Corrugated PE drainage tubing and fittings, silt-tight couplings, and coupled joints.

3.3 INSTALLATION, GENERAL

A. Install piping in accordance with Division 33 Section "Sanitary Sewers (Gravity)".

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab or drag in line, and pull past each joint as it is completed.

C. Use structures for changes in direction and size, unless fittings are indicated. Use fittings for branch connections, unless direct tap into existing sewer is indicated.

D. Extend storm drainage piping and connect to building's storm drains, of sizes and in locations indicated. Terminate piping as indicated.

E. For streets or other obstructions that cannot be disturbed, install pipe by tunneling, boring, and jacking, or a combination of both.

3.4 PIPE JOINT CONSTRUCTION AND INSTALLATION

A. General: Join and install pipe and fittings according to installations indicated.

B. PE Pipe and Fittings: As follows:
1. Join pipe, tubing, and fittings with couplings for silt-tight joints according to manufacturer's written instructions.
2. Install according to ASTM D 2321 and manufacturer's written instructions.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3. Install corrugated piping according to the Corrugated Polyethylene Pipe Association's "Recommended Installation Practices for Corrugated Polyethylene Pipe and Fittings."

C. Concrete Pipe and Fittings: Install according to ACPA's "Concrete Pipe Installation Manual." Use the following seals:
   1. Round Pipe and Fittings: ASTM C 443(ASTM C 443M), rubber gaskets.
   2. Elliptical Pipe: ASTM C 877(ASTM C 877M), Type I, sealing bands.
   3. Arch Pipe: ASTM C 877(ASTM C 877M), Type I, sealing bands.

D. System Piping Joints: Make joints using system manufacturer's couplings, unless otherwise indicated.

E. Join piping made of different materials or dimensions with couplings made for this application. Use couplings that are compatible with and that fit both systems' materials and dimensions.

3.5 CONCRETE STRUCTURE INSTALLATION

A. General: Install manholes and structures, complete with appurtenances and accessories indicated.

B. Form continuous concrete channels and benches between inlets and outlet.

C. Set tops of frames and covers flush with finished surface of structures that occur in pavements. Set tops 3 inches (76 mm) above finished surface elsewhere, unless otherwise indicated.

D. Install precast concrete sections with gaskets according to ASTM C 891.

E. Construct cast-in-place structures as indicated.

3.6 STORM DRAINAGE INLET AND OUTLET INSTALLATION

A. Construct inlets to sizes and shapes indicated.

B. Set frames and grates to elevations indicated.

C. Construct inlet head walls, aprons, and sides of reinforced concrete, as indicated.

D. Install outlets that spill onto grade with flared end sections that match pipe where indicated.

3.7 CONCRETE PLACEMENT

A. Place cast-in-place concrete according to ACI 318 and ACI 350R and in accordance with Division 03 Section "Cast-in-Place Concrete".

3.8 TRENCH DRAIN SYSTEM INSTALLATION

A. Assemble and install components according to manufacturer's written instructions.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Install with top surfaces of components, except piping, flush with finished surface.

C. Assemble channel sections to form slope down toward drain outlets. Use sealants, adhesives, fasteners, and other materials recommended by system manufacturer.

D. Embed channel sections and drainage specialties in 4-inch (100-mm) minimum concrete around bottom and sides.

E. Fasten grates to channel sections if indicated.

F. Assemble trench sections with flanged joints.

G. Embed trench sections and drainage specialties in 4-inch (100-mm) minimum concrete around bottom and sides.

3.9 CLEANOUT INSTALLATION

A. Install cleanouts and riser extension from pipe to cleanout at grade. Use cast-iron pipe fittings in pipes at branches for cleanouts and cast-iron pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in pipe.

B. Set cleanout frames and covers in cast-in-place concrete block, 18 by 18 by 12 inches (450 by 450 by 300 mm) deep.
   1. Set with tops flush with surrounding finished grade.
   2. Set cleanout frames and covers in pavement with tops flush with pavement surface.

3.10 TRENCH DRAIN INSTALLATION

A. Install type of drains in locations indicated.

B. Embed drains in 4-inch (100-mm) minimum depth of concrete around bottom and sides.

C. Fasten grates to drains if indicated.

D. Set drain frames and covers with tops flush with pavement surface.

3.11 TAP CONNECTIONS

A. Make connections to existing piping and underground structures so finished Work complies as nearly as practical with requirements specified for new Work.

B. Protect existing piping and structures to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

C. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye fitting, plus 6-inch(150-mm) overlap, with not less than 6 inches(150 mm) of concrete with 28-day compressive strength of 3000 psi(20.7 MPa).

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

D. Make branch connections from side into existing piping, NPS 4 to NPS 20(DN100 to DN500). Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye with not less than 6 inches(150 mm) of concrete with 28-day compressive strength of 3000 psi(20.7 MPa).

E. Make branch connections from side into existing piping, NPS 21(DN525) or larger, or to underground structures by cutting opening into existing unit large enough to allow 3 inches(76 mm) of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall, unless otherwise indicated. On outside of pipe or structure wall, encase entering connection in 6 inches(150 mm) of concrete for minimum length of 12 inches(300 mm) to provide additional support of collar from connection to undisturbed ground.
   1. Use concrete that will attain minimum 28-day compressive strength of 3000 psi (20.7 MPa), unless otherwise indicated.
   2. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.

3.12 CLOSING ABANDONED STORM DRAINAGE SYSTEMS

A. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:
   1. Close open ends of piping with at least 8-inch-(200-mm-) thick, brick masonry bulkheads.
   2. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.

B. Abandoned Structures: Excavate around structure as required and use one procedure below:
   1. Remove structure and close open ends of remaining piping.
   2. Remove top of structure down to at least 36 inches (1000 mm) below final grade. Fill to within 12 inches (300 mm) of top with stone, rubble, gravel, or compacted dirt. Fill to top with concrete.
   3. Backfill to grade according to Division 31 Section "Site Excavation, Backfilling, and Compaction".

3.13 FIELD QUALITY CONTROL

A. Clear interior of piping and structures of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed.
   1. In large, accessible piping, brushes and brooms may be used for cleaning.
   2. Place plug in end of incomplete piping at end of day and when work stops.
   3. Flush piping between manholes and other structures to remove collected debris, if required by authorities having jurisdiction.

B. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches (600 mm) of backfill is in place, and again at completion of Project.
   1. Defects requiring correction include the following:

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

a. Alignment: Less than full diameter of inside of pipe is visible between structures.
b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
c. Crushed, broken, cracked, or otherwise damaged piping.
d. Infiltration: Water leakage into piping.
e. Exfiltration: Water leakage from or around piping.

2. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
3. Reinspect and repeat procedure until results are satisfactory.

C. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
1. Do not enclose, cover, or put into service before inspection and approval.
2. Test completed piping systems according to authorities having jurisdiction.
3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
4. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. The work covered by this Section includes furnishing all labor, materials, tools, and equipment required to install, test, and place into satisfactory operation gas piping as shown on the Drawing and specified herein.

B. Related Sections include the following:
1. Division 23 Section "Facility Natural-Gas Piping".
2. Division 31 Section "Site Excavation, Backfilling, and Compaction".

1.3 SUBMITTALS

A. Submit product data under the provisions of other Sections of these Specifications.

B. Include data on pipe materials, pipe fittings, and accessories.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site under provisions of other Sections of these Specifications.

B. Store and protect products under provisions of other Sections of these Specifications.

PART 2 - PRODUCTS

2.1 LINE-PIPE STEEL

A. The gas supply main extending from the connections at the tie-in points of the existing system, unless otherwise noted, shall be API 5LX X52, ERW line pipe, mil coated, in at least twenty-foot (20') lengths and fabricated for butt welding. All eight-inch (8") and larger steel pipe shall have a minimum wall thickness of 0.250 inch. All two- to six- inch steel pipe shall have a minimum wall thickness of 0.154 inches.

B. A mill certificate issued by the fabricating mill will be required on all pipe stating that the minimum requirements of these specifications have been met.

2.2 WELD FITTINGS

A. All 90 degree elbows, 45 degree elbows, tees, concentric reducers, etc., shall be wrought carbon steel, Grade B, Schedule 40, and shall conform to ASA 16.9. The wall thickness of a weld fitting must be equal to or thicker than that of the pipe to which it is to be welded.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2.3 PIPE COATING

A. All underground pipe, main line or service piping shall be externally coated for the purpose of external corrosion control. This coating shall be Kendall-Polyken Brand Synergy fusion bonded multi-layer coating, 50 mils minimum and 110 mils maximum thickness. The coating must be applied on a properly prepared surface and have sufficient adhesion to the metal surface to effectively resist underfilm migration of moisture. The coating must be sufficiently ductile to resist cracking and have sufficient strength to resist damage due to handling and soil stress. All weld joints, service tees, and any attached appurtenances shall be coated with Polyken #927 pipeline primer, or equivalent and field weld wrapped with Polyken #932 joint wrap tape, or equivalent. All weld joints shall be protected by CANUSA shrink sleeves and installed per manufacturer's instructions.

B. All external protective coating must be inspected just prior to lowering the pipe into the ditch and backfilling with electric holiday detection equipment, and any damage detrimental to effective corrosion control must be repaired.

C. If coated pipe is installed by boring, driving, or other similar method, precautions must be taken to minimize damage to the coating during installation.

D. Contractor must furnish a means for a representative of the Owner/Engineer to inspect the line pipe during its coating and testing.

E. Before applying field coating and wrapping, remove from the surfaces to be coated and wrapped ALL dirt, mud, moisture, loose rust, scale, welding shag oil, grease, and other foreign matter which may adversely affect the coating and wrapping. Use scrapping, wire brushing, or power buffing to remove encrusted or adhered foreign matter. Remove oil, grease, or other soluble materials by wiping or brushing with coal tar solvent or Xylol. Clean out corners, crevices, depressions, wrinkles, or other places which harbor foreign matter.

PART 3 - EXECUTION

3.1 HANDLING OF MATERIALS

A. All materials shall be inspected for quantity and conditions by a representative of the Contractor upon arrival at delivery points, and the materials so inspected shall thereupon become the responsibility of the Contractor. If any of the material is damaged, lost, stolen, misplaced, or otherwise unaccounted for thereafter, the Owner/Engineer may, at their option, cause same to be repaired or replaced at the sole expense of the Contractor.

B. The Contractor shall take custody of the pipe at delivery point. The Contractor shall carefully inspect the pipe for the following defects and shall make appropriate remedies.
   1. Bevel Damage: Bevels which have been damaged during handling, such that they cannot be repaired by grinding, shall be cut off with a beveling machine at no cost to the Owner.
   2. Pipe Wall Defects: The pipe wall shall contain no dents, nicks, gouges, or any other noticeable defects. All defects shall be completely removed by cutting from line at no cost to the Owner.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3. The pipe to be used will be unloaded and stored in a manner so that the pipe will not be damaged and in such a manner that dirt, trash, or debris cannot get in the pipe.

3.2 WELDING, JOINING OF MATERIALS

A. All welders employed in the construction of the welded steel pipeline shall have previous pipeline welding experience and have complete working knowledge regarding welding equipment and preliminaries necessary for preparing to weld. They shall also be familiar with the preliminaries necessary to ensure good results with a maximum of safety.

B. Each welder shall be qualified in accordance with Part 192, Subpart "E", Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards, of Title 49 of the Code of Federal Regulations, and in accordance with all specifications and requirements of the State of Kentucky or any other authority having jurisdiction over this project **including latest edition of API Standard 1104**. Welding procedures shall conform to the welding procedures prescribed by the Owner. All tests of the welders shall be performed by an independent test laboratory or other such agency that may be approved by the Owner and/or Engineer. A certificate of such test results and qualified welding procedures shall be furnished to the Owner for each welder before any work is to be performed by such welder. All expenses incurred for labor, materials, machine work test and notification of such test as outlined herein shall be borne by the Contractor.

C. The Contractor shall, at all times, use only skilled workmen for welding. Each welder employed by the Contractor shall be required to satisfactorily pass a qualification test. Owner will furnish pipe for testing. The Contractor shall, at his sole expense, prepare pipe specimens, furnish welding materials, beveling machine, coupon cutter, welding machine, and the testing of pipe specimen at Pittsburgh Testing or by other approved testing. An Owner/Engineer representative shall witness all test welding.

D. Should any welder perform work that is not satisfactory to the Owner/Engineer, such workman shall be immediately released by the Contractor.

E. Line-up clamps will be used whenever practical. If an external line-up clamp is used, as much as possible of the root bead shall be completed and uniformly spaced around the circumference of the pipe and shall have an accumulative length of not less than fifty percent (50%) of the circumference before the clamp may be removed.

F. The adjoining lengths of pipe shall be accurately aligned so that all welding shall be at right angles to the axis of the pipe and accurately spaced before applying the stringer bead. Pipe shall be supported so that there is no strain on the joint, and so the pipe will be supported until the weld is complete and has cooled.

G. Before placing a joint of pipe in alignment, all dirt, mill scale, and foreign materials shall be removed from the inside of the pipe swabbing.

H. Preparatory to aligning pipe, all point, rust, scale, dirt, or other foreign materials that might affect the welding operation shall be removed by machine buffing the entire circumference of the pipe joint. The Contractor shall recut, trim, or rebevel all pipe ends as may be necessary to maintain correct alignment and spacing of the pipe using an approved type beveling machine.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

I. The welding operation shall be protected from weather conditions that would impair the quality of the complete weld.

J. Welding, when done by the shielded metal arc process, shall be performed in the vertical down direction. The current used for depositing the filler metal shall be direct reverse polarity. The pipe material shall be on the negative side of the line. The stringer bead shall be deposited, using a drag technique, so as to completely fuse the abutting edges of the lands and beveled parts of the joint, there shall be complete penetration with a minimum inside buildup. Stringer bead shall be made with 1/8 inch AWS E-6010 (Fleetweld 5, 5P or equivalent). The stringer bead shall be thoroughly cleaned before starting the Hot Pass. Power brushing may be sufficient; however, disc grinding may be required.

K. The Hot Pass shall be started immediately after completion and cleaning of the stringer bead before the stringer bead can cool – always within five (5) minutes. The 1/8 inch Hot Pass shall be made with AWS Class E-6010 (Fleetweld 5, 5P or equivalent) or AWS Class E-7010 (Shield-Arc 85 or equivalent). The Hot Pass shall be cleaned by power brushing or disc grinding. Stripper passes may be used if required. The Cover Pads shall be made using 5/32 inch AWS Class E-6010 (Fleetweld 5, 5P or equivalent) or AWS Class E-7010 Shield Arc 85 or equivalent, using a weaving motion and should be 1/32 inch to 1/16 inch higher than the pipe wall and overlay the groove by 1/16 inch on each side. The completed weld shall be thoroughly brushed and cleaned. At the completion of the day's work, all welds that have been started shall be finished.

L. If more than one welder is used to perform the work, each welder shall affix a pre-assigned welder identification code adjacent to each joint welded by the welder in question. All codes shall be placed on the top quarter of the pipe. The Contractor shall furnish the owner with a list of the welder codes. No numbers shall be reassigned. Metallic dyes shall not be used to affix codes.

M. The Owner/Engineer may direct the Contractor to remove any weld. The Owner/Engineer reserves the right to have any and all welds checked by x-ray or non-destructive testing. Destructive testing shall be furnished by the Contractor. The Contractor shall repair or replace any unsatisfactory weld at his own expense.

N. The intent and purpose of these specifications is to insure a one-hundred percent (100%) weld strength, ductility, fusion, and penetration. Each completed weld shall be free of scale, oxides, gas pockets, air pockets, pin holes, non-metallic inclusions, rivers, undercutting, dirt, slag, or other foreign inclusions or any other defects.

O. Arc burns outside the area of the finished weld shall be cause for the rejection of the weld. Weld splatter from the welding process shall not be considered an arc burn. Cracked welds shall be rejected. Pin holes, cold laps, rivers, undercutting or any defects whatsoever occurring in any weld shall be repaired or cut out and completely rewelded at no expense to the Owner.

P. If a weld is repairable, the defective area will be completely removed and the area preheated before rewelding. If a defect is then observed in the repaired area, the entire weld shall be cut out and replaced. Replacement shall be made by welding into the line a pup joint having a minimum length of two (2) feet. Replacement shall be at the expense of the Contractor.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

Q. At the end of each day's work, or at the end of sections of pipe not tied in, pipe shall be quickly capped, in order to keep out foreign matter and shall remain capped until work is resumed or pipe sections are tied in.

3.3 BENDING AND LAYING PIPE

A. The pipe shall be laid in a workmanlike manner in accordance with the best modern pipeline practice. It is intended that the word "laying," as used herein, includes bending, insertion of slack, and lowering. The Owner/Engineer may instruct the Contractor to leave "open ends" at various points during construction, which open ends shall be connected and welded at such time and in such manner as directed by the Owner/Engineer, but previous to the final test of the line. The providing of these open ends will not be done at the whim or caprice of an inspector, but at the points where the Owner or his representative has reason to believe that leaving the line with open ends for a period before the open ends are welded together will tend to relieve strains from contraction which may develop after the line has been placed in the ditch and its temperature lowered.

B. Contractor shall make all necessary field pipe bends required in the construction of the pipeline, but the Owner may, at his option, provide fabricated bends (weld ells) for installation at points where, in his judgment, the use of such bends is preferable. If such bends are used, the arc length, as measured along the crotch, must be at least one inch (1").

C. All bending shall be done by the cold stretch method. Bends shall be made by using a type of bending machine approved by the Owner/Engineer. Pipe with buckles, wrinkles, or flat spots will not be permitted in the pipeline.

D. The distance between center lines of bending points shall be one (1) pipe diameter. The maximum degree of bending at each bending point shall be one-and-one-half (1-1/2) degrees. An accurate method of measurement shall be used. No bend shall be made nearer than four feet (4') to the end of the joint of pipe. When pipe is double jointed before bending, bend shall not be closer to the weld than three feet (3'). Departure from pipe roundness (the difference between the long and short diameters of the pipe) in any bend shall not exceed two and one-half percent (2-1/2%) of the nominal diameter of the pipe. On pipe containing a longitudinal weld, the longitudinal weld must be as near as practicable to the neutral axis of the bend.

E. All pups five (5) feet and over shall be moved ahead daily and installed in line. There shall be a full joint of pipe installed between pups.

F. Any pipe that is buckled, wrinkled, flattened, or distorted shall be cut out and replaced at the Contractor's expense.

G. The Contractor shall lay all pipe so that it conforms with the contour of the ditch. Overbends shall be made in such a manner that the middle of the bend shall clear the high point of the bottom of the ditch.

H. Sag bends shall fit the bottom of the ditch. Side bends shall conform to the outside of the ditch. There shall be no points in the ditch where it is necessary to scrub or force the pipe into the ditch to obtain proper depth or lineup. Pipe shall fit the ditch without the use of external force to hold it in place until the backfill is completed.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

I. Contractor shall furnish a high-voltage electrical holiday detector and shall operate this detector at the voltage setting required by Owner for that type coating. Contractor shall make a detailed inspection of the coating for holidays and imperfections immediately preceding the lowering in of the pipe. All holidays and damaged places in the coating shall be repaired by the Contractor until the detector is passed over the entire pipe without disclosing any holidays or imperfections in the coating.

J. All pipe shall be lowered slowly and carefully. The Contractor shall repair any coating damaged in the handling, lowering, or moving of the pipe in the ditch so as to leave it in a condition equal to that of the undamaged coating. In lowering coated pipe in rock areas, a four-inch (4") limestone dust or sand shall be placed in the bottom of the ditch, and the ditch shall be thoroughly padded above the pipe with eight inches (8") of limestone dust or sand for protection.

K. All mains shall have a minimum cover of thirty-six inches (36"), in consolidated rock, twenty-four inches (24") is allowable. State regulations on amount of cover will apply along state rights-of-way.

L. The pipeline must be installed with at least twelve inches (12") of clearance from any other underground structure not associated with the pipeline. If this clearance cannot be attained, approval must be obtained from the Owner's representative before installing pipeline with less clearance. The pipeline must be protected from damage that might result from the proximity of the other structure.

M. Plastic mains shall be handled carefully to avoid excessive stress or cracking. Pipe shall be snaked from side to side within the trench to provide an excess length of pipe to offset contraction.

3.4 BACKFILL, CLEAN-UP, AND PAVING

A. After lowering in has been completed, but before backfilling, the ditch will be inspected to be sure no skids, boulders, cans, debris, or other foreign materials are in the ditch. The pipe, when lowered in, shall rest firmly on the bottom of the trench throughout its length.

B. After the pipe has been inspected in the ditch, the Contractor may backfill the ditch. Rock, gravel, or like materials shall not be backfilled directly onto the pipe. The Contractor shall provide eight inches (8") of compacted dirt, limestone dust, or sand over the pipe before backfilling when such conditions exist.

C. Plastic pipe shall be inspected for damage before backfilling, and any pipe sections containing cuts or gouges must be replaced.

D. Backfill shall not include debris such as stumps, brush, large rock, etc.

3.5 TESTING OF PIPELINE

A. The Contractor shall furnish all necessary labor, equipment, compression, and any other supplies required to complete the pressure testing of the pipeline.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. The Contractor shall give the Engineer and the Owner ample advance notice (minimum of two [2] working days) of all proposed tests, and conduct all pressure tests in the presence of the Engineer and/or Owner.

C. The test pressure during the tests shall be measured on an accurate recording type pressure gage within 24 hour chart, furnished and installed by the Contractor. The recording pressure gage shall be calibrated before beginning of test with a dead weight tester, furnished by the Contractor. Additional calibrations with a dead weight tester will be required as instructed by the Owner and/or the Engineer.

D. Testing Pressure and Test Duration:
   1. All pipe shall be tested at 150 percent of each system's or sub-system's MAOP for a minimum duration of eight (8) hours.

E. Test medium for these specifications is air. Other test mediums may be substituted, such as water, or inert gases, if approved by the Engineer. Should a different medium be approved, the line pressures and the frames herein stated shall still apply. The intent of the testing procedures shall not be altered by the selection of a test medium.

F. The Contractor shall fill the test sections with air, measure the test pressure with an accurate recording test pressure gage with twenty-four (24) hour chart. The test gage shall show no drop in pressure for a minimum of eight (8) hours after the source of test pressure has been disconnected from the pipeline section involved in the test and the temperature of the test medium has been allowed to equalize. The Contractor shall locate and repair all leaks which may be disclosed by the tests, and repeat the tests as required for approval.

G. All charts used in the tests shall be identified with the test date, section of pipeline involved, test pressure, and the Contractor's signature. The Contractor shall deliver to the Owner two (2) photostatic or Xerox copies of these charts. All test charts shall be twelve inches (12"), twenty-four (24) hour, recording charts. All test gages shall be a minimum of four-and-one-half inches (4-1/2") in diameter or bigger, depending on the accuracy required from the test.

H. Approved test chart gage ranges:

Test Pressure (PSI)	**Type Piping**	**Gages (PSI)**	**Chart (PSI)**
60-150	Distribution	0-150	0-150
150-300	Distribution	0-300	0-300
300-600	Transmission	0-600	0-600
600-1000	Transmission	0-1000	0-1000

I. All tests shall have a gage at the point where the air is being put into the line, and the point furthest from the recording chart and one at the point where the recording chart is located.

J. Piping shall, in no case, show any drop in pressure during the test except what may occur due to temperature changes. It is strongly recommended that once the pipe has been presurrized to the proper pressure that it sits for a period of time to allow pressure and temperature to stabilize. The pipeline should stand the test pressure without leakage for a minimum of eight (8) consecutive hours. The Owner shall approve or reject the test.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

K. Compressors, used in pumping the line up, shall in no way inject any type of lubricant or any foreign matter into the line.

L. The Contractor will assure that non-destructive testing in the form of x-rays is completed on ten percent (10%) of the welds for this project, at the Contractor's expense. The Contractor shall number the x-rays, and then place the x-ray numbers on a set of the plan drawings to associate the x-rays with weld locations.

M. Liquid Leak Tests (Soap Test)
1. All above ground fittings, valves, equipment, gages, piping and joints shall be tested with a suitable liquid leak detection solution before any paint or coating is applied.
2. To be a valid test, no signs of bubbling will be allowed.
3. All test results shall be recorded.

3.6 PIPELINE TIE-INS

A. The Contractor shall make "tie-ins" to the existing piping as shown on the plans. However, should the underground piping be discovered to be different than shown on the plans, the Contractor will make "tie-ins" at the direction of the Engineer.

B. Connecting new lines to existing mains shall be accomplished without interrupting normal gas service. Connections shall be in accordance with the American Standard Code for pressure piping.

C. Where new lines are to tie to existing mains, the connection shall be accomplished by a side outlet spherical tee. Isolation of the section of main to be removed shall be accomplished with line stopper fitting that will accommodate a bypass line. Line stopper fitting and valve shall be equal to those manufactured by Mueller Company or T. D. Williamson, Inc.

D. Ties to existing main shall be made only during the time specified by the resident inspector.

E. Should, for any reason, gas service be discontinued during the tie-in operations, it shall be the responsibility of the Contractor to close each existing gas service affected. When gas service is returned, it shall be the responsibility of the Contractor to reopen all gas services and ignite all pilots for all gas-operated appliances, at his expense.

3.7 PURGING

A. New Lines: Before placing in service, purge all new lines with gas to remove all air and explosive mixtures, using proper safety precautions. Purging gas shall be furnished by the Contractor.

B. Existing Piping: Before temporarily or permanently taking existing piping out of service, purge all pipe with air to remove all gas and explosive mixtures, using proper safety precautions.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3.8 INTERNAL CLEANING

A. Prior to testing, internally clean all new piping with a suitable Apig≅ type cleaner forced by air pressure through the pipe line 3 or more times until line is thoroughly cleaned.
   1. The first two cleanings shall be performed with a wire brush type pig.
   2. All subsequent cleanings may be performed with a polyurethane or polyethylene type pig.
   3. If a large amount of water is present during pigging, the line shall be dried in accordance with the Section on ADEHYDRATING THE PIPE LINES≅ described herein, using a suitable squeeze type pig.

B. Provide a suitable barrier in front of the open ends of the pipe to catch the cleaners in order to prevent injury to personnel.

C. The line shall be pigged three times or more until the line is thoroughly cleaned. Air shall be forced through the line after pigging to ensure that all smaller particles and dust are removed. Compression used for forcing the pig through the line or blowing air through the line shall not inject any type of oil, lubricant or other foreign mater into the line.

3.9 CATHODIC PROTECTION TEST STATION

A. The test station shall be J. Miller Industries, Inc., Model JMI-TOF-072-WH or approved equal. The station shall include #12 AWG wire and warning decals similar to pipeline markers. Contractor shall install two (2) #12 AWG wires to the terminals and CAD weld (with #15 shot) to the gas main one pipe diameter apart. One wire shall be white and the other wire shall be black. The black wire shall be west of the white wire.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following general-duty valves and accessories:
1. Plug valves (PV-1).
2. Air and vacuum valves (AV-1).
3. Solenoid valves (SV-1 or SV-2).
4. Hose bibs (HB-1).
5. Mud valves (MV-1).
6. Yard hydrant (YH-1).
7. Cast-iron gate valve (GV-1).
8. Pressure reducing valves (PRV-1).
9. Knife gate valves (KV-1).
10. Ball valve (BV-1).
11. Check valve (CV-1).
12. Butterfly valve - water service (BF-1).
13. Butterfly valve - air service (BF-2).

B. Related Sections include the following:
1. Division 09 Section “Protective Coatings” for painting requirements for valves, gates, and accessories.
2. Division 40 piping Sections for general-duty and specialty valves for site construction piping.
3. Division 40 piping Sections for specialty valves applicable to those Sections only.

1.3 SHOP TESTING

A. All check valves shall be subjected to hydrostatic, shop leakage and performance tests as specified in AWWA C508.

B. Plug valves and all other valves shall be subjected to hydrostatic test at two times the rated pressure of the valve, shop leakage and performance tests. During the hydrostatic test, there shall be no leakage through the metal, the end joints, or the shaft stem seal, nor shall any part be permanently deformed. Leakage shall not exceed that permitted by ANSI B16.104, Class IV, for metal-seated valves and Class VI for resiliently seated valves.

1.4 SUBMITTALS

A. Product Data: For each type of valve indicated. Include body, seating, and trim materials; design data; pressure/head and temperature classifications; end connections; arrangement; dimensions; and required clearances. Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Shop Drawings: Complete dimensional data, including plans, elevations, and sections as necessary to completely and accurately depict the valves to be furnished.

C. Valve Schedule: Schedule of all valves indicating the service, size, connections, make, manufacturer, model number, and special features.

D. Installation, Operation, and Maintenance Information: Manufacturer's written instructions for valve installation, operation, and maintenance for inclusion in manuals specified in Division 1.

1.5 REFERENCES

A. ASTM A126 - Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings

B. ASTM A743 - Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, and Nickel-Base Corrosion-Resistant for General Application

C. ASME Compliance for Ferrous Valves: ASME B16.10 and ASME B16.34 for dimension and design criteria.

D. NSF Compliance: NSF 61 for valve materials for potable-water service.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set angle, gate, and globe valves closed to prevent rattling.
4. Set ball and plug valves open to minimize exposure of functional surfaces.
5. Set butterfly valves closed or slightly open.
6. Block check valves in either closed or open position.

B. Use the following precautions during storage:
1. Maintain valve end protection.
2. Store valves indoors and maintain at higher than ambient dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

1.7 QUALITY ASSURANCE

A. General: The valve manufacturers shall furnish a written certification to the Engineer that all valves comply with all applicable requirements of the governing AWWA standards specified herein.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Valves shall be the product of a recognized manufacturer whose personnel have been regularly engaged in the design and manufacture of such equipment. The manufacturer must be able to demonstrate experience with the design, fabrication, supply, and successful operation of valves of similar size and capacity. The manufacturer shall demonstrate upon the request of the Engineer that:
   1. They maintain a reasonable stock of spare parts.
   2. They employ sufficient qualified technical personnel to insure adequate servicing and operational control advice.

C. Installer: Installation, calibration and testing of valves and equipment furnished under this section shall be performed by qualified, skilled technicians who are regularly engaged in such activities involving systems of similar complexity, and who posses all licenses and certificates required to perform such work.

D. Provide a list of references (name, location, and contact information) of at least three (3) operating installations currently using the same or similar model proposed located in the United States.

PART 2 - PRODUCTS

2.1 GENERAL

A. Contractor shall note that all valves, especially in the smaller sizes, may not be shown completely on the drawings. The Contractor shall furnish and install all valves indicated and required for proper operation of the equipment or services requiring such valves.

B. Contractor shall be responsible for coordinating the location and position of valve operators. Operator positions for each valve shall be clearly shown on shop drawings.

C. Each valve body shall have cast thereon the word “OPEN,” an arrow indicating the direction to open, and flow direction arrows.

D. Surface preparation and coatings shall be in accordance with Division 09 Section "Protective Coatings".

2.2 PLUG VALVES (PV-1)

A. General: All plug valves shall be eccentric plug valves with rectangular ports.

B. All valves and actuators shall be as manufactured by DeZurik or approved equal.

C. Valves shall be of the non-lubricated eccentric type with resilient faced plugs and flanged end connections faced and drilled to the ANSI B16.5 150 pound.

D. Bodies shall be of ASTM A126 Class B cast iron. Bodies in 4” (100mm) and larger valves shall be furnished with a 1/8” (3mm) welded overlay seat of not less than 90% pure nickel.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

Seat area shall be raised, with raised surface completely covered with weld to insure that the plug face contacts only nickel. Screwed in seats shall not be acceptable.

E. Plugs shall be of ASTM A126 Class B cast iron. The plug shall have cylindrical seating surface eccentrically offset from the center of the plug shaft. The interference between the plug face and body seat, with the plug in the closed position, shall be externally adjustable in the field with the valve in the line under pressure. Plug shall be Chloroprene (CR) or resilient facing suitable for application.

F. Valves shall have sleeve type metal bearings and shall be of sintered, oil impregnated permanently lubricated type 316 ASTM A743 Grade CF-8M in .5 - 36" (15 - 900mm) sizes. In valves larger than 36" (900mm), the upper and lower plug journals shall be fitted with ASTM A-240 type 316 stainless sleeves with bearings of ASTM B30, Alloy C95400 aluminum bronze. Non-metallic bearings shall not be acceptable.

G. Valve shaft seals shall be of the multiple V-ring type and shall be externally adjustable and repackable without removing the bonnet or actuator from the valve under pressure. Valves utilizing O-ring seals or non-adjustable packing shall not be acceptable.

H. Pressure ratings shall be 175 psi on sizes up to 12” and 150 psi for 14” and larger. Every valve shall be given a hydrostatic and seat test with test results being certified when required by these specifications.

I. Manual valves shall have gear actuators, extension stems, floorstands, etc., as indicated on the plans. All gearing shall be enclosed in a semi-steel housing and be suitable for running in a lubricant with seals provided on all shafts to prevent entry of dirt and water into the actuator. The actuator shaft and quadrant shall be supported on permanently lubricated bronze bearings. Actuators shall clearly indicated valve position and an adjustable stop shall be provided to set closing torque and to provide seat adjustment to compensate for change in pressure differential or flow direction change. All exposed nuts, bolts and washers shall be zinc plated. Valves and gear actuators for buried or submerged service shall have seats on all shafts and gaskets on the valve and actuator covers to prevent the entry of water. Actuator mounting brackets for buried or submerged service shall be totally enclosed and shall have gasket seals. All exposed nuts, bolts, springs and washers shall be stainless steel.

J. Actuators shall be equipped with an operating nut to allow manual valve operation in case of supply failure.

2.3 AIR AND VACUUM VALVES (AV-1)

A. General: Combination air and vacuum valves for sewage and process wastewater shall permit unrestricted escape of air while pipelines are being filled. When a pipeline is full of liquid, the air and vacuum valve shall close watertight when liquid enters the valve. The valve shall allow small pockets of air, which accumulate when the pipeline is operating under pressure, to escape through a small orifice appropriately sized for a working pressure of 250 psi. The air/vacuum valve shall also permit large quantities of air to enter through the orifice when the pipeline is being drained to break the vacuum.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Manufacturer: Air and vacuum valves shall be Vent-o-mat™ Series 2GX-B Air Valve or approved equal.

C. Valve Construction and Design:
   1. Each air and vacuum valve shall consist of a compact tubular all stainless steel fabricated body, hollow direct acting float and solid large orifice float in H.D.P.E. - stainless steel nozzle and woven dirt inhibitor screen, nitrile rubber seals and natural rubber seat.
   2. The valve shall have an integral anti-surge orifice mechanism, which shall operate automatically to limit surge pressures rise or shock induced by closure to less than two times the valve rated working pressure.
   3. The intake orifice diameter shall be equal to the nominal size of the valve, e.g., a six-inch valve shall have a six-inch diameter intake orifice.
   4. Large orifice sealing shall be effected by the flat face of the control float seating against a nitrile rubber 'O' ring housed in a dovetail groove circumferentially surrounding the orifice.
   5. Discharge of pressurized air shall be controlled by the seating and unseating of a small orifice nozzle on a natural rubber seal affixed into the control float. The nozzle shall have a flat seating land surrounding the orifice so that damage to the rubber seal is prevented.
   6. The valve construction shall be proportioned with regard to material strength characteristics, so that deformation, leaking or damage of any kind does not occur when the valve is subjected to a pressure two times greater than the valve rated working pressure.
   7. Valve inlet connection for valves larger than two inches shall be flanged conforming to ANSI B16.1 Class 250 or ANSI B16.5 Class 300. Flanged ends shall be supplied with the required number of stainless steel bolts inserted for alignment to the specified standard, as well as nuts, washers, and gaskets.

D. Valve Operation:
   1. Prior to the ingress of liquid into the valve chamber, such as when the pipeline is being filled, valves shall vent through the large orifice when sewage/effluent approach velocities are relative to a transient pressure rise, on valve closure, of less than twice the valve rated pressure. At higher sewage/effluent approach velocities, which have a potential to induce transient pressure rises greater than twice the valve rated pressure on valve closure, the valve shall automatically discharge air/gas through the anti-surge orifice and reduce sewage/effluent approach velocity, such that on valve closure, a maximum transient pressure rise of less than twice the valve rated pressure is realized.
   2. Valves shall not exhibit leaks or weeping of liquid past the large orifice seal over the range of operating pressures from 7.3 psi to twice rated working pressure.
   3. Valves shall respond to the presence of air/gas by discharging it through the small orifice at any pressure within the specified range of operating pressures, i.e. 7.3 psi to 250 psi, and shall remain leak tight in the absence of air.
   4. Valves shall react immediately to pipeline drainage or liquid column separation by the full opening of the large orifice so as to allow unobstructed air intake at the lowest possible negative internal pipeline pressure.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2.4 SOLENOID VALVES (SV-1 OR SV-2 – EXPLOSION-PROOF)

A. General: Unless otherwise specified, two-way solenoid valves shall be of the packless type with full-area ports. Four-way solenoid valves shall be of the 2-position, poppet type and shall feature tight seating discs with zero leakage. Solenoid valves shall be furnished with a NEMA-4 solenoid chamber enclosure and shall be designed for operation on 120V, 60 hertz, single-phase power. The valve shall be explosion-proof where required by conditions and when specified or indicated. Unless otherwise shown or required, 2-way valves shall be normally closed (when de-energized). Conduit connection box shall be integral with solenoid chamber. Valves shall be UL listed and CSA approved. Solenoid valves shall be wired into the related equipment control circuit so that the valves are open (energized) whenever the equipment is running. Solenoid valves shall not require differential pressure for operation.

B. Manufacturer: Solenoid valves shall be as manufactured by Automatic Switch Company, or approved equal.

C. Construction: Valve body shall be forged brass or stainless steel with resilient seat of Viton, Buna-N, or Teflon. Coils shall be molded, continuous-duty coils with epoxy-encapsulated, Class F insulation.

2.5 HOSE BIBBS (HB-1)

A. General: Hose bibbs shall be angle-hose valves of bronze construction suitable for 200 PSI minimum working pressure. Valves shall have a renewable Teflon or resilient disc and shall be furnished with a 3/4” inch male hose outlet connection. Valves shall be furnished with a tamper-proof vacuum breaker. Valves shall be furnished with a suitable cap and chain.

B. Construction: Body and bonnet shall be bronze in accordance with ASTM B62. Inlet connection shall be threaded per ANSI B2.1. Handwheel shall be cast iron.

2.6 MUD VALVES (MV-1)

A. Mud valves (4- to 24-inches) shall have an ASTM A-126 cast-iron frame and yoke of rising stem configuration with a flanged end. Valve shall have a bronze-to-bronze seat and bronze stem and stem nut. Valve shall be provided with handwheel, floor stand, extension stems, and stem guides, as herein specified. Valve shall be Style 140-02 as manufactured by M & H Valve Company or approved equal.

2.7 YARD HYDRANTS (YH-1)

A. Refer to Division 33 Section “Hydrants” for detailed specifications.

2.8 CAST-IRON GATE VALVES (GV-1)

A. Manufacturers:
   1. Type I, Cast-Iron, Rising-Stem Gate Valves:
      a. Crane Co.; Crane Valve Group; Crane Valves.
      b. Crane Co.; Crane Valve Group; Jenkins Valves.
      c. Crane Co.; Crane Valve Group; Stockham Div.
      d. Approved equal.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Cast-Iron Gate Valves, General: MSS SP-70, Type I.

C. Class 250, OS&Y, Bronze-Mounted, Cast-Iron Gate Valves: Cast-iron body with bronze trim, rising stem, and solid-wedge disc.

2.9 PRESSURE REDUCING VALVES (PRV-1)

A. Water pressure reducing valves shall have bronze body construction, union inlet connection, renewable seat module, integral stainless steel strainer and high-temperature resistant reinforced diaphragm for hot water.

B. Valve shall have an adjustable pressure range of 25 to 75 psi and be serviceable in-line. Standard pressure setting: 50 psi; maximum pressure: 300 psi.

C. Manufacturer:
1. Watts Industries.
2. Or approved equal.

2.10 KNIFE GATE VALVE (KV-1)

A. Valve shall be uni/bi directional lug type valve according to the MSS-SP-81 and TAPPI TIS 405-8 standard for industrial service applications.

B. Body shall be a one-piece integrally cast stainless steel with raised face flanges, full port design and have a pressure rating of 200 psi.

C. Gate shall be polished on both sides for a tighter seal in the packing chamber, machined-beveled gate end.

D. Knife gate shall have flange drilling per ANSI B 16.5, Class 150. All bolt holes shall be tapped.

E. Materials:
1. Body - CF8M.
2. Gate - AISI 316.
3. Seat - AISI 316.
4. Packing - Braided PTFE or synthetic fiber with EPDM O-ring.
5. Stem - AISI 316.
6. Yoke - Carbon steel.

F. Acceptable Manufacturers:
1. DeZurik.
2. Orbinox Series 20.
3. Hilton Valve, Figure H-200.
4. Or approved equal.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

G. Knife Gate Valve Schedule:

GATE ID		Size		Operator Type
BSKV-7131A1		10"		Manual
BSKV-7231A1		10"		Manual
BSKV-7151A2		10"		Electric
BSKV-7251A2		10"		Electric
BSKV-7152A2		10"		Electric
BSKV-7252A2		10"		Electric

2.11 FERROUS-ALLOY BALL VALVES (BV-1)

A. Manufacturers:
1. Conbraco Industries, Inc.; Apollo Div.
2. Crane Co.; Crane Valve Group; Stockham Div.
3. Flow-Tek, Inc.
4. Hammond Valve.
5. Jamesbury, Inc.
6. Kitz Corporation of America.
7. Milwaukee Valve Company.
8. NIBCO Inc.
9. PBM, Inc.
10. Jomar Valve Company.
11. Approved equal.

B. Ferrous-Alloy Ball Valves, General: MSS SP-72, with flanged ends.

C. Ferrous-Alloy Ball Valves: Class 150, full port.

D. Acceptable Manufacturers - Domestic Hot Water Circuit Balancing Valves:
1. Circuit balancing valves 1/2 inch to 2 inch for domestic hot water service shall be Nibco Globe Style, Series 1710 or approved equal. Valve shall have integral metering/test ports for flow balancing and flow measurement. Test ports shall have internal check valve and be equipped with caps. Valves shall be manufactured from dezincification resistant brass or bronze rated 240 psi at 250 degrees Fahrenheit. All balancing valves shall have position indication readout and built in memory stop for repeatable regulation and control.
   a. Nibco T or S1710
   b. Tour & Anderson Stad/Stas
   c. Armstrong Model CBV
   d. Approved equal.

E. Circuit Balancing Valves:
1. 2 Inch and Smaller: Dezincification resistant brass body bonnet and stem, EPDM stem seals and seat o-ring, positive shutoff, integral memory stop, differential pressure test ports, and position display window on handle.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2.12 GRAY-IRON SWING CHECK VALVES (CV-1)

A. Manufacturers:
   1. Type II, Gray-Iron Swing Check Valves with Composition to Metal Seats:
      a. Crane Co.; Crane Valve Group; Crane Valves.
      b. Crane Co.; Crane Valve Group; Stockham Div.
      c. Mueller Co.
      d. Watts Industries, Inc.; Water Products Div.
      e. Approved equal.
   2. Grooved-End, Ductile-Iron Swing Check Valves:
      a. Grinnell Corporation.
      b. Mueller Co.
      c. Victaulic Co. of America.
      d. Approved equal.

B. Gray-Iron Swing Check Valves, General: MSS SP-71.

C. Type II, Class 125, gray-iron, swing check valves with composition to metal seats.

D. Type II, Class 250, gray-iron, swing check valves with composition to metal seats.

E. 175-psig(1207-kPa) CWP Rating, Grooved-End, Swing Check Valves: Ductile-iron body with grooved or shouldered ends.

2.13 BUTTERFLY VALVES - WATER SERVICE (BF-1)

A. Butterfly valves 48 inches in size and smaller shall be flanged or mechanical joint as shown on the Drawings.
   1. Valves shall meet or exceed the latest revision of AWWA Standard C504 for Class 150B butterfly valves and shall meet or exceed the requirements of this Specification. Valves 12 inches and smaller shall have a working pressure of 200 psi. All valves shall be tested at and shall be capable of withstanding bi-directional line hydrostatic test pressures up to 225 psi without leaking. All valve components shall conform to U.L. classification in accordance with ANSI/NSF Standard 61.
   2. All butterfly valves and actuators shall be Model BAW Butterfly Valves as manufactured by DeZurik or approved equal.
   3. Valve bodies shall be of cast iron per ASTM A126 Class 150B. Flanged end valves shall be of the short body design with 125-pound flanged ends faced and drilled per ANSI B16.1 standard for cast iron flanges. Mechanical joint end valves shall meet the requirements of AWWA C111/ANSI 2.11.
   4. Disc shall be offset to provide an uninterrupted 360-degree seating edge and shall be cast iron per ASTM A48, Class 40C. The disc seating edge shall be solid Type 316 stainless steel. Sprayed matting seating surfaces are not acceptable. The disc shall be securely attached to the valve shaft utilizing a field removable/replaceable Type 304 stainless steel torque screw on sizes 3- to 12-inches, a tangential pin locked in place with a set screw on sizes 4- to 20-inches, or Type 304 stainless steel taper pins on valves 24-inches and larger.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

5. Valve shaft shall be Type 304 stainless steel. Valve shaft seals shall be self-compensating V-type packing with a minimum of four sealing rings. One-piece molded shaft seals and O-ring shaft seals are not acceptable.
6. Seat shall be of Buna-N, or as required for service, and shall be molded in and vulcanized to the valve body. The seat shall contain an integral shaft seal protecting the valve bearings and packing from any line debris. For valves 24 inches and larger, the seat shall be retained within a dovetail groove in the valve body and locked in place by an epoxy compound wedge. Compression between the seat and disc edge shall be adjustable from both the upstream and downstream side of the valve disc and the seat shall be field replaceable without disassembly of the disc and shaft. Seats vulcanized to cartridge inserts in the valve body and seats on the disc are not acceptable.
7. Valve shaft bearings shall be non-metallic and permanently lubricated.
8. Interior and exterior metallic surfaces shall be shop painted per the latest revision of AWWA C504 unless otherwise indicated. The interior of the body shall have a full rubber lining vulcanized to the valve body. Mechanical joint valves shall be fully rubber lined to the point of pipe insertion. Rubber lining on the flange face and boot style seats are not acceptable.
9. Valve actuator shall be sized to operate the valve at the rated working conditions of the valve, and shall be as shown on the Drawings. Ten position locking levers shall be available for 3- to 6-inch valves. Provisions must be made for locking in any of the 10 positions using a standard padlock.
10. Each valve and actuator shall be assembled, adjusted, and tested as a unit per the latest revision of AWWA C504, by the valve manufacturer. Valves with actuators mounted outside of the valve manufacturing facility are not in accordance with AWWA latest revision and shall not be acceptable. Shop leakage tests shall follow the requirements of AWWA C504 except that the test pressure shall be 225 psi.

2.14 BUTTERFLY VALVES - AIR SERVICE (BF-2)

A. Valves shall be of the flangeless wafer body style suitable for use with ANSI 125-150 pound flanges. Bodies shall be cast iron rated for 175 psi and shall provide drip-tight shutoff at differentials up to 175 psi. Bodies of flangeless wafer valves shall have four flange bolt guides to center the body in the pipeline.

B. All resilient seated butterfly valves shall be Model AR1 Butterfly Valves as manufactured by Tyco/Keystone or approved equal.

C. Valve bearings shall be self-lubricated bronze with shaft seals to prevent leakage and to protect bearings from internal or external corrosion.

D. Seats shall be of the reinforced resilient type and shall be field replaceable. Seats shall also act as a body liner to prevent flow from contacting the body casting. Seats shall have flange sealing to provide a positive seal without the use of flange gaskets. Seats shall be Viton, suitable for a maximum of 300 degrees.

E. Shafts shall be one piece and shall be Type 416 stainless steel. Shaft diameter shall meet the 75B Standard from AWWA Specification C504-87 for butterfly valves. Shafts shall be finished ground to minimize bearing and shaft seal wear. Shafts 12 inches and larger shall have a non-adjustable thrust collar.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

F. Disc shall be cast-iron with welded nickel edge. The disc-to-shaft connections shall be Type 316 stainless steel. Pins, shaft, and disc of all valves shall be individually machined and completely interchangeable.

G. Valves shall be available with field interchangeable manual or powered actuators as required. The actuator-to-shaft connection shall be designed to shear and prevent internal valve damage if the disc closes on foreign material in the pipeline. All non-buried actuators shall provide external indication of disc position.

H. Manual actuators shall be infinite position levers for valves 6-inches and smaller which allow for manual throttling and locking in any position from open to close. Manually actuated valves 8 inches and larger shall be operated using a cast iron housed handwheel. All units are to have adjustable open and close position stops with a provision to prevent accidental adjustment changes. Operating shaft is to be supported axially and radially at input end by permanently lubricated bronze thrust and sleeve bearings.

I. Valves shall be supplied with stem extensions, floorstands, extended bonnets, etc., as shown on the Drawings. All extended bonnets must have gear located at the operator. Stem extensions with handwheel operators are not an acceptable equivalent.

2.15 MANUAL VALVE OPERATORS (A1)

A. Unless otherwise shown or specified, valves shall be furnished with manual operators as follows:
   1. Gate valves and plug valves 8-inches and smaller that are installed above grade and less than 7 feet above the working surface shall have a lever operator.
   2. Gate valves and plug valves greater than 8-inches that are installed above grade and less than 6 feet above the working surface shall have a rotary operator with handwheel.
   3. Gate valves and plug valves located more than 6 feet above the working surface shall have a rotary operator with chainwheel. Extend chains to a height of 60 inches above finished floor elevation.
   4. Gate valves and plug valves 8-inches and smaller that are installed for buried service shall have a 2-inch operating nut, extension stem, and valve box.
   5. Gate valves and plug valves greater than 8-inches that are installed for buried service shall have a rotary operator with extension stem, 2-inch operating nut, and valve box.

B. Valves shall be arranged to open counterclockwise by handwheel or lever operation unless otherwise indicated in these specifications. Where necessary for operations as described above, valves shall be bevel or spur gear operated. Plug valves six inches and larger shall be gear operated, unless specified otherwise.

C. Operating nuts for buried valves shall be standard 2-inch square nuts and shall conform to all applicable standards. Extension stems, valve boxes, and stem guides shall be furnished where shown, specified, or required for proper operation.

D. Hand lever operators shall have heavy-duty cast iron bracket, cast iron latching lever, and self-lubricating bushings and shall be capable of securing the valve in any position. Lever operators shall be installed so that the lever is parallel with the axis of the pipe in which the valve is installed when the valve is fully open.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

E. Rotary manual operators for above ground service shall be of the worm gear or traveling nut type. Rotary operators shall have a heavy-duty, weatherproof cast iron or steel housing with gasketed, removable cover and shall be equipped with a mechanical dial or slot type position indicator and suitable hand wheel. Manual operators shall be totally enclosed and sealed to prevent the entrance of rain, dirt, and corrosive atmospheres. Traveling nut operators shall have a grease lubricated alloy steel screw stem, brass nut, and self-lubricating bronze bushings. Worm gear operators shall have hardened, grease-lubricated alloy steel worms and bronze worm gears. All exterior bolts and fasteners shall be bronze or stainless steel for corrosion resistance. The valve shall open with counterclockwise rotation of the hand wheel.

F. Rotary manual operators for buried service shall conform with the paragraph above except, the operator shall be totally enclosed and completely sealed to prevent the entrance of water and dirt. Buried operators shall be coated with a bituminous coating. Manual rotary operators shall be capable of withstanding 300 foot-pounds of torque on the operating nut or hand wheel. A corrosion resistant, dial type valve position indicator shall be provided at the operating nut on the extension stem of the buried operators to provide a remote indication of valve position.

G. Chain wheel operators shall be of heavy cast iron construction and shall be equipped with chain guide and looped, flexible, operating chain. Chain shall be galvanized or cadmium plated and shall extend to within 48-inches of the floor.

H. All manual rotary and lever operators shall be capable of seating or unseating the valve disc under the most adverse conditions in the particular application with no more than an 80-pound pull on the hand wheel or lever. Valve operators shall be capable of holding the valve in any position between fully open and fully closed without creeping or fluttering. Operators shall be provided with adjustable, mechanical, stop-limiting devices to prevent over-travel of the valve disc in the open and closed positions. Manual rotary and lever operators shall comply with all applicable requirements of AWWA C504.

I. Contractor shall be responsible for coordinating the location of valve operators. Operator locations for each valve shall be clearly shown for each valve on the shop drawings.

2.16 ELECTRIC VALVE OPERATOR (A2)

A. Manufacturers:
   1. Auma.
   2. Limitorque.
   3. EIM.
   4. Approved equal.

B. Operating Stands (where shown on the Drawings): Mount electric operator drive unit on a heavy pattern operating stand designed to transfer the thrust to the concrete floor. Anchor Bolts and Nuts: ASTM A276, Type 316 stainless steel.

C. Drive Units:
   1. Electric actuator shall include the electric motor, reduction gearing, valve stern drive nut/bushing, position limit switches, mechanical overload torque switches, ductile iron gear case and automatic declutchable handwheel.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2. Motor speed reduction shall be by means of a gear train consisting of hardened steel spur gears and self-locking worm and worm gear set. The worm shall be heat treated alloy steel and have worm thread surface rolled or ground. The worm gear shall be bronze. Non-metallic gears in the power train are not acceptable.
3. All gearing and shafting shall be supported on anti-friction bearings. All thrust components shall be supported by use of tapered roller bearings.
4. The actuator shall be furnished with a handwheel located in a 90 degree plane from the actuator output drive, with a maximum rim pull requirement of 60 pounds for valve travel loads. An external manual declutch lever shall be included to place actuator in the manual mode. The lever shall not require more than a 10 pound force to engage even when the valve has been tightly seated. The lever is to be padlockable in either handwheel or motor mode. Operation by motor shall not cause the handwheel to rotate, or operation of the handwheel shall not cause the motor to rotate. Handwheel shall operate in the clockwise direction to close.
5. All gearing and bearing shall be grease lubricated and suitable for year-round service based on prevailing ambient temperature conditions.
6. Electric motors shall be 480 VAC, 3-phase specifically designed for valve actuator service, and be totally enclosed, non-ventilated. The enclosure shall meet NEMA 4. Motor shall be capable of operation under maximum specified loads when voltage to the motor is +/- 10% of the nominal voltage. Motor shall have Class F insulation with thermal overload sensors imbedded in the motor windings. Provide with self-contained lockable disconnect switch.
7. Limit switches shall be geared to the drive mechanism and in step with actual valve position at all times, whether operation is by power or manual mode. Switches shall be activated by a rotor type design. Contacts shall be silver and have a rating of 10 amps at 120 VAC. A minimum of (3) N.O. and (3) N.C. contacts shall be provided for each direction of travel. The limit switch gear mechanism shall be enclosed to prevent entrance of foreign matter or wire entanglement. The use of cams or screws to set switches or designs requiring battery back-up methods to ensure position control in the event of a power failure, are unacceptable.
8. The actuator shall include an adjustable torque switch to interrupt the motor power circuit when an obstruction is encountered in either direction of travel or when torque seating of valves is required for tight shut off. The torque switch shall have a calibrated dial for adjustment and have means to ensure maximum actuator rating as limit switch. Mechanical torque springs for load control shall be field replaceable without need of actuator dismantling or removal of the worm assembly.
9. Local position indication for quarter valves shall be by indicator dial located on the gear operator and graduated in 25 percent increments. If remote position indication is specified, this shall be by means of 1000 ohm potentiometer in step with valve position at all times whether operation is electrical or manual.
10. As a minimum, the actuator shall be furnished with power and control terminal strips, space heater (25 watt), limit switches, torque switches, all housed in control compartment meeting Nema 4 (weatherproof). The rectangular enclosure shall have a bonded o-ring seal and hinged cover. Cover bolting shall be captive stainless hex head screws.
11. Built-in controls shall be an integrated modular package, completely wired and be easily removable or replaceable, as a complete package, by removal of four (4) captivate screws. Motor leads and power supply leads will be terminated to the terminal strips located on the modular package. Power supply terminals (5 points

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

minimum) and control supply terminal (48 points minimum) shall be physically isolated from each other to protect against transient voltages. The terminal strips shall be completely shrouded with high impact resistant plastic to avoid accidental terminal contact by personnel. The module is to include a snubber circuit to provide control voltage protection switches and electronic modules from voltage surges. All electrical components of the modular package, such as reversing contactor, transformer, etc., shall be unidirectional plug connected to provide easy removal and replacement without concerns for proper wiring connections. All optional control require-ments such as modulating control, 2-sire control, interposing relays, etc., shall be plug-in printed circuit type boards having gold plated contact connectors. Unless otherwise specified, all P boards must be temperature rated -40° to + 70°C. Ease of replacement or upgrading shall be of paramount consideration.

12. Reversing Contactor Control voltage shall be 120 volts, 60 Hz. N.O. Seal-in contacts for momentary contact pushbutton control and N.C. contacts for electrical interlock shall be supplied. When specified, additional auxiliary contacts (I N.O. and I N.C. for open and close coils) shall be supplied. The contactor shall be both electrically and mechanically interlocked. It shall be completely wired as an assembly and plug connected to the modular package.
13. The transformer assembly shall provide 115, 18 and 12 Vac. It shall be epoxy impregnated and encapsulated to prevent moisture incursion and shall be completely wired as an assembly and plug connected to the modular packaged.
14. Each actuator shall be supplied with open-stop-close pushbuttons furnished integrally mounted. Pushbuttons shall be double o-ring sealed and include a protective silicon boot. Seal material shall be resistant to ozone and ultraviolet light. When integrally mounted pushbuttons are specified, the design shall permit operation of the button, when the electrical enclosure cover is open.
15. The actuator hall include a two (2) long life-high intensity LED type pilot lights to indicate open, closed and intermediate valve position (both lamps on). Red shall indicate valve open and green shall indicate valve closed.
16. The actuator shall include a 3-position selector switch, for local (hand)-off remote (auto) control. If specified the switch shall be padlockable in any position.

2.17 EXTENSION STEMS

A. Extension stems shall be solid steel not smaller than the stem of the valve. Extension stems shall connect to the valve by a flexible socket coupling. All couplings shall be pinned, keyed, or socket type.

B. Extension stems for buried service valves shall extend to within 6-inches of the top of the valve box or floor box and shall be provided with spacers which will center the stem in the valve box. A standard 2-inch nut shall be provided on the top of the extension stem.

C. Stem guides shall be bronze-bushed, cast iron construction adjustable in two directions. Stem guides shall be installed so the unsupported length of the extension stem does not exceed 10 feet or an L/r of 200.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2.18 FLOORSTANDS

A. Floorstands shall be of the heavy-pattern type and shall be constructed of cast iron or steel. Floorstand shall have a height of approximately 36 inches. The floorstand shall have an integral bottom flange suitable for bolting to a concrete floor.

B. Floorstands for manually operated non-rising stem valves shall be furnished with a slot-type position indicator in the floorstand body. Floorstands for rising stem valves shall have a removeable stem cover with slot type position indicator. Stem covers shall consist of a galvanized, slotted steel pipe attached to the top of the floorstand with a pointer riding up and down in the slot. The open and closed points shall be marked on the pipe cover.

C. Floorstands for rising stem valves shall be provided with a bronze operating nut supported by tapered, grease-lubricated roller or ball bearings. Positive mechanical seals shall be provided on the operating nut where it passes through the floorstand housing to retain lubricant and exclude dirt. Lubricating fittings shall be provided for lubricating bearings.

D. Handwheels shall have a minimum diameter of 14 inches and shall be designed to seat or unseat the valve at the maximum differential with not greater than a 40-pound tangential pull on the handwheel rim. An arrow and the word "OPEN" shall be cast on the handwheel in raised letters.

E. Each floorstand shall have a conspicuous, permanently attached nameplate showing the valve manufacturer's name, valve size, model designation, serial number, and any other pertinent information. Nameplate shall be of corrosion resisting metal with raised or stamped lettering and contrasting background.

F. Floorstands shall be set vertical and plumb with the valve operating stem for free operation without binding or distortion. Floorstand shall be shimmed and grouted in place as required for proper installation.

G. Following manufacture, interior and exterior, nonmachined, nonbearing ferrous floorstand surfaces shall be blast-cleaned and painted at the factory with 1 coat of zinc chromate primer conforming to Federal Specification TT-P-645 and 1 coat of compatible alkyd enamel. Interior surfaces of floorstands shall be protected for the life of the unit by a minimum of 3 coats of an approved paint.

2.19 T-HANDLE OPERATING WRENCH

A. The Contractor shall furnish ten (10) T-handle, steel valve operating wrenches with sockets compatible with standard 2-inch square valve operating nuts.

B. The operating wrenches shall be 42 inches in length.

2.20 VALVE TAGS

A. Tagging: 1-1/2 inch diameter heavy brass or stainless steel tag attached with No. 16 solid brass or stainless steel jack chain for each valve, bearing the valve tag number shown on the Drawings.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine piping systems for compliance with requirements for installation tolerances and other conditions affecting performance.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

C. Operate valves and gates in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

D. Examine threads on valves, mating pipes, and gate stems for form and cleanliness.

E. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

F. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Piping installation requirements are specified in other specification sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. All valves and appurtenances shall be installed in strict conformance with the drawings and manufacturer's instructions.

C. Valves shall be installed in such a way operators and packing are easily accessible. Valves with field replaceable seats shall be installed with sufficient clearance to permit removal of valve bonnet and stem without removing valve from the line.

D. Install valves with stems positioned in the horizontal or above the centerline of the pipe. Operators shall be positioned so they do not interfere with pedestrian traffic. In passageways or above platforms the minimum clearance between the floor and the lowest protruding point on the valve or operator shall be six feet, eight inches (6'-8"). All valves shall be accessible for operation, maintenance or removal.

E. Positioners or actuators shall be provided special support where they overhang from the valve or where the total valve, actuator and position weight is excessive for the size of pipeline.

F. Locate valves for easy access and provide separate support where necessary.

G. Install valves in position to allow full stem movement.

H. Install check valves for proper direction of flow.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

I. Install gates in accordance with manufacturer's written instructions.

3.3 FIELD TESTING

A. Following installation, all valves shall be tested by the Contractor under anticipated operating conditions. The ability of the valves to operate properly without leakage, binding, sticking, fluttering, or excessive operating torque shall be demonstrated to the satisfaction of the Engineer. The Contractor shall at his own expense adjust and/or replace any valve as necessary to assure satisfactory operation.

B. Following installation and testing, all ferrous and non-machined surfaces of exposed valves, operators, floorstands, and stem guides shall be cleaned primed and painted with a finish suitable for the intended service in accordance with the requirements of Division 9 Section "Painting".

3.4 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes process piping, fittings, accessories and supports and installation and testing requirements.

B. Contractor shall furnish, install, and test (where required), all process piping, fittings, accessories, and supports as required in this Specification.

C. Related Sections include the following:
1. Division 23 Section "Facility Natural-Gas Piping".
2. Division 33 Section "Sanitary Sewers (Gravity)".
3. Division 33 Section "Gas Lines".
4. Division 40 Section "Process Valves".

1.3 REFERENCES

A. ANSI A.21.10 - Standard for Cast Iron Fittings 3- through 48-inches, for water and other liquids.

B. ANSI A.21.50 - Standard for the Thickness Design of Ductile-Iron Pipe.

C. ANSI B.16.1 - Standard for Cast Iron Pipe Flanges and Flanged Fittings.

D. ANSI B.16.5 – Steel Pipe Flanges and Flanged Fittings.

E. C115/A21.15 - Standard for Flanged Ductile Iron.

F. ANSI-C-606 - Standard for Joints, Grooved and shouldered Type Fittings.

G. AWWA C208 - Hydrostatic Testing of Steel Pipe.

H. ANSI B.31 - Pressure Piping.

1.4 SUBMITTALS

A. Submit product data under provisions of other Sections of this specification.

B. Include data on pipe materials, pipe fittings and accessories.

1.5 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of piping and specialties and are based on the specific system indicated.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Comply with regulatory requirements of local, state and federal agencies having jurisdiction.

C. Piping material shall bear label, stamp, or other markings of specified testing agency.

D. Comply with ASTM F645 for selection, design, and installation of thermoplastic water piping.

E. Comply with ASTM specifications for materials.

F. The pipe manufacturer must furnish the Engineer a notarized certificate stating that the pipe furnished has been manufactured and tested in accordance with the applicable standards.

1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Delivery: Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.

B. Storage:
   1. Protect stored piping from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside.
   2. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

C. Handling: Protect flanges, fittings, and specialties from moisture and dirt.

PART 2 - PRODUCTS

2.1 DUCTILE IRON PIPE

A. Ductile iron pipe and fittings shall be as specified in Division 33 Section "Sanitary Sewers (Gravity)".

B. Wall penetrations connecting buried outside piping and inside piping, or tank penetrations below water level, shall consist of ductile iron wall sleeves imbedded in concrete with mechanical joint or flanged connections compatible with piping system.

C. Wall penetrations that are located above grade where water infiltration is not a concern that penetrates poured-in-place concrete shall consist of ductile iron wall pipe embedded in the concrete with connections compatible with the piping system.

D. All ductile iron pipe and cast iron fittings shall be furnished as shown in the piping schedule and on the plans.

E. Joints for ductile iron pipe and cast iron fittings shall be flanged, mechanical joint, push-on joint, or mechanically coupled grooved joint as indicated on the drawings and as specified in "Joining of Pipes" in this division.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

F. Where required, pipe and fittings shall be furnished with approved lugs or hooks cast integrally for use with bolts or bridle rods and socket clamps to keep pipe from pulling apart under pressure.

G. All ductile iron pipe and fittings (except air systems) shall be lined and coated as specified in Division 33 Section "Sanitary Sewers (Gravity)" with the exception that:
   1. The inside shall be cement-mortar lined (standard thickness) for water service in accordance with ANSI/AWWA C104/A21.4.
   2. Machined surfaces shall be cleaned and coated with a rust-preventive coating at the shop immediately after being machined.

H. Pipes and fittings shall be subjected to a careful inspection and hammer test just before being installed.

I. Ductile air piping and fittings will not be lined.

2.2 STEEL PIPE

A. All steel pressure pipe shall conform to the requirements of ANSI/AWWA C200 and shall be hydrostatically tested to the pressures indicated in that specification.

B. Pipe shall be shop fabricated. Field welding will not be permitted without written permission of the Owner's Representative.

C. Pipe sizes, joints, wall thicknesses, (or thickness schedule), shall be as indicated in the Pipe Schedule included with these specifications.

D. Pipe 6 inches and larger shall be electrically welded or seamless steel pipe, Grade B.

E. Pipe less than 6 inches shall be seamless steel pipe, Grade B.

F. Steel pipe shall be black or hot-dipped galvanized in accordance with ANSI/ASTM A120. Stainless steel pipe shall be in accordance with ASTM A312. Steel pipe up to 2 inches diameter shall be butt-welding type.

G. Fittings:
   1. Fittings for steel pipe 6 inches and larger shall be fabricated from hydrostatically tested pipe in accordance with AWWA C208. Wall thickness shall conform to that specified for the pipe.
   2. Fittings up to 2 inch diameter shall be malleable iron conforming to ANSI B16.19, 300 psig, black or galvanized. Stainless steel fittings shall conform to ANSI/ASME B36.19.
   3. Fittings up to 2-1/2 inch through 4 inch shall be forged steel, standard class, conforming to ANSI/ASTM A234 and ANSI B16.9 or, in the case of grooved ends, malleable iron.

H. Flanges:
   1. For 4 inch and larger pipes, flanges shall conform to ANSI/AWWA C207, Table 1, 2, or 3, depending on pressure.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2. Flanges for piping 2-1/2 inch to 4 inch shall be weld neck type conforming to ANSI/ASTM A181.
3. Piping up to 2 inch shall be socket-weld type.

I. Couplings:
1. Pipe couplings shall be mechanical type, to mechanically engage and lock grooved or shouldered pipe ends in a positive couple and to allow for some degree of angular deflection and contraction and expansion. Each coupling shall consist of malleable iron housing clamps in 2 or more parts, a single C-shaped composition sealed gasket designed to utilize internal pipe pressure to increase the tightness of the seal when installed, and 2 or more track-head steel bolts as required to assemble housing-clamps. The couplings shall be as manufactured by Victaulic Co. of America, South Plainfield, NJ; by Gustin/Bacon Division of Aeroquip, Lawrence, KS, or approved equal.

J. Inspection:
1. All pipe and fittings shall be inspected and tested in accordance with the applicable AWWA Specifications by an independent commercial testing laboratory approved by the Owner prior to shipment of the pipe. Certified copies of the reports of inspection and testing as required by the ANSI/AWWA Specification shall be submitted for all pipe and fittings furnished before final acceptance. All inspection and testing shall be accomplished at no additional expense to the Owner.

K. Gaskets for flat face flanges shall be full face type. Gaskets for raised face flanges shall conform to requirements for "Group I Gaskets" in ANSI B16.5. Gaskets 12 inches in diameter and smaller shall be 1/16 inch thick minimum; larger than 12 inches in diameter shall be 3/32 inch thick minimum and of following types:
1. Water and Sludges (up to 175 degrees F): Red rubber, heavy duty type, by John Crane Co., Morton Grove, IL, - Style 555, or approved equal.
   a. Plant Air: Neoprene type by John Crane - Style 999, or approved equal.
   b. Chemical feed, Teflon coated type by John Crane - Style 11FF, free flow with neoprene insert, or approved equal.

2.3 GALVANIZED STEEL PIPE

A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M, for butt and socket welding.
3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.

2.4 INSULATED STEEL PIPING

A. Steel Pipe: ASTM A 53/A 53M, black steel, plain ends, Type, Grade, and Schedule as specified below:
1. NPS 2 (DN 50) and Smaller: Schedule 40, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.
2. NPS 2-1/2 through NPS 12 (DN 65 through DN 300): Schedule 40, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3. NPS 14 through NPS 18 (DN 350 through DN 450): Schedule 30, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.
4. NPS 20 (DN 500) and Larger: Schedule 20, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.

B. Mineral-Fiber, Preformed Pipe Insulation:
1. Products: Subject to compliance with requirements, provide one of the following: Johns Manville; Micro-Lok.
   a. Knauf Insulation; 1000 Pipe Insulation.
   b. Manson Insulation Inc.; Alley-K.
   c. Owens Corning; Fiberglas Pipe Insulation.
   d. Or approved equal.
2. Type I, 850 deg F (454 deg C) Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
3. Type II, 1200 deg F (649 deg C) Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type II, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

C. Factory-Applied Jackets:
1. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
   a. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
   b. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
   c. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
   d. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.

D. In addition to the thermal fluid piping, Contractor shall provide 200-gallon catchment tank with all appurtenances and piping, as shown on the Drawings.

E. Dryer Flexible Connections
1. Provide flexible connections for the thermal fluid piping, sludge piping connection to dryer and dryer exhaust scrubber drain as follows:
2. Thermal Fluid Piping Expansion joint to be bellows type (150# ANSI B16.5 flange). Bellows to be T316 stainless steel with 316 stainless steel liner. Expansion joint compensation of 2.5 inches.
3. Sludge Pipe at Dryer Expansion joint to be bellows type (150# ANSI B16.5 flange). Expansion compensation to be 3.125 inches. Note: Fabrication of 10-inch pipe through 12-inch expansion joint with 12-inch flange and 12- by 10-inch concentric reducer by contractor.
4. Drain Connection Connector 316 stainless steel inner corrugated hose type 150# ANSI B16.5 flange. Connector to have 304 stainless steel wire braid over inner hose.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

Connector to have 316 stainless steel liner. Face to face dimension to be 36 inches to allow for adequate movement.

5. Equipment Supplier: Connector shall be supplied by The Metraflex Company or approved equal.

2.5 STAINLESS STEEL

A. Stainless steel, Schedule 10S, Type 304.

B. Fittings:
   1. Bevel end NiHard 4 (ASTM A532, Class 1, Type D), 550 Brinell Hardness cast elbows, laterals, reducers, and tees with couplings, gaskets, and bolt set.
   2. Induction hardened, 600 Internal Brinell Hardness, alloy steel bent pipe elbow and fabricated laterals and tees with ASTM A105, 150-pound pattern slip-on flanged ends.
   3. All pipe connections shall be bolted gasketed flanged joints.

2.6 FIBERGLASS REINFORCED PIPE (FRP)

A. General:
   1. Laminate consisting of a corrosion barrier, a structural layer, and an exterior finish.
   2. Meet requirements of the properties and visual acceptance criteria in ASTM D2563, Level I.

B. Resin:
   1. Premium grade corrosion resistant vinyl ester resin, suitable for continuous exposure to saturated water vapor, hydrogen sulfide gas, and their associated acidic products.
   2. Corrosion Barrier Resin: Vipel F010, or approval equal.
   3. Structural Layer and Surfacing Layer Resin:
      a. Vipel F701 or approval equal.
      b. Use the same resin throughout the structural layer.
      c. Structural layer resin shall contain a minimum of 3 percent antimony trioxide to achieve required flame spread index.
   4. Add ultraviolet absorbers to surfacing resin to improve weather resistance.
   5. No dyes, pigments, or colorants except in exterior gel coat, which is to have white pigment.
   6. No fillers or thixotropic agents.

C. Resin Curing System:
   1. Use resin manufacturer's currently recommended cure system.
   2. Cure products to a minimum of 90 percent of the minimum Barcol hardness specified by resin manufacturer.
   3. Measure Barcol hardness according to ASTM D2583.
   4. Post-cure the tank and appurtenances in accordance with resin manufacturer's recommendation for time and temperature.
   5. Post-curing shall be completed with warm-to-hot dry air, free of combustion products. Hot spots shall be avoided.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

D. Reinforcement:
   1. Corrosion Barrier:
      a. Resin-rich interior surface of nominal 100 to 120 miles.
      b. Reinforce inner surface with a resin-rich surfacing veil of 10 to 20 mils thick.
      c. Use at least two plies of chopped strand mat to back the veil.
      d. Use no additive in the corrosion barrier.
      e. The resin content of the inner surface shall be a minimum of 80 percent by weight.
      f. Glass content of combined inner surface and interior layer shall be 27 percent plus or minus 5 percent.
   2. Structural Layer:
      a. The structural layer shall be filament wound.
      b. Filament winding shall be with continuous strand roving to provide a glass content of 50 to 80 percent.
   3. Exterior Finish: No reinforcement required.
   4. Reinforcing Materials:
      a. Veil: Electrically conductive material, carbon fiber veil, 12 to 16 mils thick, with a finish and a binder compatible with the lay-up resin.
      b. Chopped Strand Mat: Type E glass, minimum 1-1/2 ounces per square foot, with silane finish and styrene soluble binder.
      c. Continuous Roving:
         1) Type E glass.
         2) Type E glass with a silane type finish, with a nominal yield of at least 100 strand yards per pound; used for filament winding.
      d. Woven Roving: Type E glass, nominal 24 ounces per square yard, 4 by 5 weave, with silane type finish.

E. Laminate:
   1. The inner corrosion layer shall be resin rich, not to exceed 20 percent plus or minus 5 percent glass by weight and a minimum thickness of 10 to 15 mils.
   2. The inner corrosion layer shall be followed by at least two layers of chopped-strand mat or two passes of chopped roving to a total of 3 ounces per square foot.
   3. Should the chopped roving technique be employed, the chopped fibers shall be 1/2 inch to 2 inches in length.
   4. The total corrosion barrier shall total 100 mils minimum and be 27 percent plus or minus 5 percent glass by weight.
   5. Exterior: Finish with white gel coat.

F. Workmanship:
   1. Visual defects, per ASTM D2563, shall not exceed Level II on the vessel interior and Level III on the vessel exterior.
   2. Finished vessel wall shall be free, as commercially practicable, of visual defects such as foreign inclusions, air bubbles, pinholes, pimples, crazing, cracking, and delaminations that will impair the serviceability of the vessel.
   3. All cut edges where openings are cut into the tanks shall be trimmed smooth.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

G. Dimensions and Tolerances:
   1. The minimum required wall thickness for the cylinder straight shell shall be sufficient to support its own weight in an upright position without any exterior support.
   2. Flat areas shall be provided to allow locating large fittings on the cylinder straight shell.
   3. All dimensions will be taken with the tank in the vertical position, unfilled.
   4. Tank dimensions will represent the exterior measurements.
   5. The tolerance for the outside diameter, including out-of-roundness, shall be per ASTM D1998.
   6. The tolerance for fitting placements shall be plus or minus 0.5 Inch in elevation and 2 degrees radial at ambient temperature.

H. Marking:
   1. Identify each tank with the fabricator's name, capacity in galloons, maximum temperature, design pressure/vacuum, specific gravity, pH, resin, minimum thickness, vessel number, vessel name, and date of manufacture.
   2. Seal decals, labels, etc. into the laminate exterior with clear resin.

2.7 HIGH DENSITY POLYETHYLENE (HDPE PIPE)

A. Pipe shall be manufactured from a PE 3408 resin listed with the Plastic Pipe Institute (PPI) as TR-4. The resin material will meet the specifications of ASTM D3350 with a cell classification of PE:345464C. Pipe shall have a manufacturing standard of ASTM F714. Pipe O.D. size shall be ductile iron pipe size (DIPS) for pipe 3-inches and larger and iron pipe size (IPS) for pipe smaller than 3-inches. Pipe shall be DR 11 (200 psi WPR) unless otherwise noted or shown on the Drawings. The pipe shall contain no recycled compounds except that generated in the manufacturer's own plant from resin of the same specification from the same raw material. All pipes shall be suitable for use as pressure conduits, listed as NSF 61, and per AWWA C906, have nominal burst values of three and one-half times the Working Pressure Rating (WPR) of the pipe. Peak flow water velocity of 5 ft./sec. shall be used in the hydraulic engineering design.

B. High-Density Polyethylene (HDPE) Fittings:
   1. Butt Fusion Fittings: Shall be PE3408 HDPE, Cell Classification of 345464C as determined by ASTM D3350-02, and approved for AWWA use. Butt Fusion Fittings shall have a manufacturing standard of ASTM D3261. Molded and fabricated fittings shall have a pressure rating equal to the pipe unless otherwise specified in the drawings. Fabricated fittings are to be manufactured using Data Loggers. Temperature, fusion pressure, and a graphic representation of the fusion cycle shall be part of the quality control records. All fittings shall be suitable for use as pressure conduits, and per AWWA C906, have nominal burst values of three and one-half times the Working Pressure Rating (WPR) of the fitting.
   2. Electrofusion Fittings: Shall be PE3408 HDPE, Cell Classification of 345464C as determined by ASTM 3350-02. Electrofusion fittings shall have a manufacturing standard of ASTM F1055. Fittings shall have a pressure rating equal to the pipe unless otherwise specified on the plans. All electrofusion fittings shall be suitable for use as pressure conduits, and per AWWA C906, have nominal burst values of three and one-half times the Working Pressure Rating (WPR) of the fitting. All electrofusion couplings and fittings must use a 3-pin fusion system.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3. Flanged and Mechanical Joint Adapters: Shall be PE 3408 HDPE, Cell Classification of 345464C as determined by ASTM D3350-02. Flanged and mechanical joint adapters shall have a manufacturing standard of ASTM D3261. Fittings shall have a pressure rating equal to the pipe.

C. Manufacturer:
1. Rinker Polypipe.
2. CP Chem Performance Pipe.
3. JM Manufacturing.
4. Approved equal.

2.8 MECHANICALLY COUPLED GROOVED JOINTS

A. Mechanical coupling connections shall mechanically engage, lock and seal the grooved pipe ends in a positive couple. Each coupling shall consist of malleable iron housing clamps in two or more C-shaped composition sealing gaskets, designed such that internal pressure tends to increase the tightness of the seal and two or more track-head steel bolts.

B. Approved manufacturers are Gustin Bacon Div. of Aeroquip Corp., Lawrence, KS, (Style 100 with Type 1 gaskets); Victaulic Company of America, South Plainfield, NJ, (Style 77 with Grade T gaskets for steel pipe; Style 31 with flush seal gaskets for cast iron and ductile iron pipe); or approved equal.

C. Couplings used for the accommodation of drop nipples, branches, sprinkler heads, gages or other male threaded connections shall be Style 96 FIT reducing tee, as manufactured by Victaulic Company of America, South Plainfield, NJ, or approved equal.

2.9 MECHANICALLY COUPLED PLAIN END JOINTS

A. Mechanical coupling connections shall mechanically engage, lock and seal the steel pipe plain ends in a positive couple. The coupling housing shall be cast with oval shaped bolt holes. The assembly shall include a gasket which seals without pressure or vacuum when properly assembled. The couplings shall be Style 99 Roust-A-Bout with steel jaws which engage the pipe. Manufacturer is Victaulic Company of America, South Plainfield, NJ, or approved equal.

2.10 FLEXIBLE CONNECTORS

A. On suction and discharge side of pumps, flexible rubber connectors shall consist of multiple plies of rubber fabric impregnated with special compounds and reinforced with helical wound wire. End flanges shall be integral with the fabric and wire reinforced bodies and shall be backed up with galvanized steel retaining rings. Flanges and retaining rings shall be drilled to ANSI standards. Restraining rods and gusset plates shall be provided on the connector where anchoring is not practical. Rods and plates shall be steel and shall have rubber grommets to isolate the rods from the plates. Flexible rubber connectors shall be as manufactured by Mercer Rubber Company, General Rubber Corporation, or approved equal.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Flexible metal connectors shall be fabricated from Type-400-SS and designed with annular or helical close pitch corrugations for sizes 2-1/2- through 6-inches and open pitch for larger pipe sizes. Connectors shall be braided with wire sheath of the same type of metal as the corrugated portion of the connector. End fittings shall be threaded female couplings, male nipples, or 250-pound flanges drilled to ANSI specifications as indicated. Flexible metal connectors shall be as manufactured by Flexonics, Resistaflex Corporation, or approved equal.

2.11 FLEXIBLE CONNECTORS FOR LOW-PRESSURE AIR PIPING AND THERMAL FLUID PIPING (BELLOWS TYPE)

A. To provide for thermal expansion and contraction that will occur in pipeline resulting in axial and/or lateral movement of the pipe. Calculations and selection shall be based on a maximum temperature of 500 degrees F. for the thermal fluid piping. Low pressure air piping shall be based on a maximum temperature variation of 50 degrees F.

B. Manufacturer: Abbott Rubber Company or approved equal.

C. Material: Stainless steel.

2.12 PIPING SCHEDULE

A. Major pressure piping shall conform to the schedule below:

Service	Pipe Class or Schedule	Fittings
Wet Cake Lines	DIP flanged with pressure rating of 250 psi	ANSI/AWWA C110/A21.10 to match ANSI B 16.1, Class 250 Flanges
Compressed Air-Wet Cake Lines for Flushing	Galvanized Steel, ASTM A53/A53M-07	A126, ASME B16.4
Plant Water - Booster Pump	Stainless Steel, ASTM A312 Schedule 40S	ANSI/ASME B36.19
Plant Water Distribution - Inside	DIP flanged with pressure rating of 250 psi	ANSI/AWWA C110/A21.10 to match ANSI B 16.1, Class 250 Flanges
Plant Water Distribution - Outside (Buried)	DIP Push-on with pressure rating of 250 psi	ANSI/AWWA C153/21.53 to match ANSI B16.1, Class 250 Flanges
Tank Drainage - All Areas	DIP Push-on with pressure Class 200 pipe	ANSI/AWWA C153/A21.53 to match ANSI B16.1, Class 250 Flanges
Thermal Fluid	Insulated Steel, ASTM A53/A53M, Schedule 40, Type S, Grade B	ASME B16.4, Class 150

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

Service	Pipe Class or Schedule	Fittings
Odorous Air	FRP, ASTM D2996, Type 1, Grade 2, Class E	ASTM D2996, Type 1, Grade 2, Class E
Pneumatic Conveying Line	Stainless Steel Schedule 10S, Type 304	ASTM A532, Class 1, Type D
Nitrogen Gas	Galvanized Steel, ASTM A53/A53M-07	A126, ASME B16.4
Natural Gas - Above Grade	Galvanized Steel, ASTM A53/A53M-07	A126, ASME B16.4
Natural Gas - Below Grade	HDPE, ASTM D2513	ASTM F1055
Mineral Oil Piping	Insulated steel ASTM A53/A53M Schedule 40, Type S, Grade B	ASME B16.4, Class 150

PART 3 - EXECUTION

3.1 GENERAL

A. Where piping connects to equipment, particular care shall be taken to see that pipe fittings are suitable for connection to the equipment fittings.

B. All piping shall be erected true to line and grade by skilled mechanics in strict accordance with the specifications and drawings.

C. Where walls and piping systems are parallel to one another, the piping shall be grouped or arranged to present a symmetrical appearance.

D. All piping connections to pumps and other equipment shall be made in such a manner as to avoid any strain being transmitted from the piping to the equipment. Flanged piping shall be carefully installed so that the pipe flanges exactly match and are perfectly parallel to the flanged equipment connections.

E. Connections of piping to equipment with bolts more than finger-tight will not be permitted until equipment has been leveled, grouted in, and installation inspected and approved by the manufacturer of the equipment. In the event the piping does not exactly match the equipment connections, the piping installation shall be revised until it does match those connections. In the case of flanged connections, it must be possible to insert the bolts by hand without "springing" the piping. In no event during the erection of the piping shall it be permitted to support the weight of any fitting, valve, piping, etc., from the equipment connections.

F. All piping shall run parallel with the building walls unless otherwise indicated. Diagonal runs will not be permitted. In all walkways, stair and working platform areas, a minimum clearance of 6 feet 8 inches from the floor, stair, or platform to the lowest point of the piping or piping accessory shall be maintained.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

G. The Contractor shall be cognizant of the service and design features such as support anchoring, expansion/contraction, and jointing of the piping and valves he proposes to utilize. He shall inform the Owner of any features which are not compatible with the drawings at the time such equipment is submitted for approval.

H. Piping from safety valves shall be the same as inlet piping.

I. All pipe nipples shall be of the same material as the line in which they are installed.

J. The placement of valves, instruments and other components shall be located such that they can be serviced and can be read (in the case of instruments).

K. Unless otherwise indicated on the drawings, maximum spacing of pipe supports for horizontal piping shall be as follows:

	Maximum Spacing	
Pipe Material	**Liquids**	**Air & Gases**
Steel (standard weight or heavier), Ductile Iron		
1-1/2" and under	7'-0"	7'-0"
2", 2-1/2", 3"	10'-0"	14'-0"
4", 5", 6"	14'-0"	20'-0"
8", 10"	20'-0"	20'-0"
12" and above	As recommended by piping manufacturer	

L. Provide additional supports, a) where pipe changes direction, b) adjacent to flanged valves and strainers, and c) at equipment connections and heavy fittings. Provide at least one hanger adjacent to each joint in cast-iron pipe and grooved-end steel pipe with mechanical couplings.

3.2 INSTALLATION

A. Pipe Erection and Laying:
1. Carefully inspect all pipe, fittings, valves, equipment, and accessories prior to installation. Any items which are unsuitable, cracked or otherwise defective shall be rejected and removed from the job immediately. All pipe, fittings, valves, equipment and accessories shall have factory applied markings, stampings or nameplates with sufficient data for identification to determine their conformance with specified requirements.
2. Exercise all necessary care at every stage of storage, handling, laying and erecting to prevent entry of foreign matter into piping, fittings, valves, equipment and accessories. Do not erect or install any item which is not clean. During construction, until system is fully operational, all openings in piping and equipment must be kept closed at all times except when actual work is being performed on that item or system. Closures shall be plugs, caps, blind flanges or other items specifically designed and intended for this purpose.
3. Run pipelines straight and true, parallel to building lines with a minimum use of offsets and couplings. Provide only such offsets as may be required to provide necessary headroom or clearance and to provide necessary flexibility in pipe lines.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

4. Changes in direction of pipelines shall be made only with fittings or pipe bends. Changes in size shall be made only with fittings. Miter fittings, face or flush bushings, or street elbows shall not be used. All fittings shall be of the long radius type, unless otherwise shown on the drawing or specified.
5. Provide flanges, dismantling joints, or unions at all final connections to equipment, traps and valves to facilitate dismantling. Arrange piping and piping connections so that equipment being served may be serviced or totally removed without disturbing piping beyond final connections and associated shutoff valves.
6. Use full and double lengths of pipe wherever possible.
7. Unless otherwise indicated, install all supply piping, including shutoff valves and strainers, to coils, pumps and other equipment at line size with reduction in size being made only at inlet to control valve or pump. Install supply piping from outlet of control valve at full size to connection of equipment served.
8. All pipe shall be cut to exact measurement and installed without springing or forcing except in the case of expansion loops where cold springing is indicated on the drawings. Particular care shall be taken to avoid creating, even temporarily, undue loads, forces or strains on valves, equipment or building elements with piping connections or piping supports.

B. Hangers and Supports:
1. The requirements of the applicable sections of ANSI B31 "Pressure Piping" shall be considered as minimum requirements governing fabrication, installation and support of piping systems except where more specific or stringent requirements re-stated herein or shown on the drawings.
2. In general, all pipes larger than 10 inches diameter shall be supported from foundations, beams or roofs. Piping smaller than 10 inches may be supported from or on the building slabs. Pipe hangers shall be in accordance with those manufactured by Fee & Mason, Manasquan, NJ; ITT Grinnell Corp., Providence, RI; Carpenter & Patterson, Inc., Woburn, MA, or approved equal.
3. All piping and piping connected equipment, including valves, strainers, traps and other specialties and accessories shall be supported in a manner that will not result in or produce objectionable or excessive stress, deflection, swaying, sagging or vibration in the piping or in the building structure either during erection, cleaning, testing or normal operation of the systems. Piping shall not be so restrained, however, as to cause it to shake or buckle between supports or anchors or to prevent proper movement due to expansion and contraction. Piping shall be supported at equipment and valves such that they can be disconnected and removed without further supporting the piping. Piping shall not introduce any strains or distortion to the connected equipment.
4. All concrete inserts for support shall be set in place prior to pouring concrete.
5. All auxiliary structural steel required for the support of piping systems and not shown on the drawings as having been installed as a part of the building structure shall be furnished, installed and prime painted as part of the work under this section. Attach auxiliary steel to building structure as detailed on the drawings.
6. Hangers and supports shall be installed complete, including lock nuts, clamps, rods, bolts, couplings, swivels, inserts and required accessory items. Hangers for horizontal piping shall have adequate means of vertical adjustment for proper alignment of pipe and shall be provided with lock nuts. All hangers and supports in direct contact with copper tubing shall be copper plated or plastic coated.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

7. Parallel runs or horizontal pipe 3 inches and under may be supported on trapeze type hangers made up of structural shapes and hanger rods. Otherwise, pipe lines shall be supported with individual pipe hangers.
8. Hanger rods for both single and double rod hangers shall conform to the following:

Pipe Size	Hanger Rod Diameter
2 inch and smaller	3/8 inch
2-1/2 inch to 3-1/2 inch	1/2 inch
4 inch, 5 inch	5/8 inch
6 inch	3/4 inch
8 inch to 12 inch	7/8 inch
Larger than 12 inch	1 inch

9. It shall be the responsibility of the Contractor to coordinate the location and method of support of the piping systems with that of all installations under other sections of the specifications. Piping shall be supported in such a manner as to impose no eccentric loading on building structural members. The loading of any hanger or support shall in no case exceed the manufacturer's recommended maximum load.
10. Hangers for insulated piping shall be sized for the OD of the pipe insulation or the insulation protection saddle.
11. Pipe hangers and supports are not shown on the plans. Contractor is responsible for coordination of the design, subject to Engineer’s approval of a suitable hanger and/or support system.

C. Draining and Venting:
1. Unless otherwise indicated on the drawings, all horizontal water, plant air, gas, including runouts and branches, shall pitch or slope to low points to provide for complete drainage, removal of condensate and venting. Pitch, unless otherwise indicated, shall be 1 inch in 40 feet. All waste, vent, and roof leader piping shall pitch a minimum of 1/4 inch per foot.
2. Maintain accurate grade where lines are pitched or sloped for venting and drainage. No lines shall have pockets due to changes in elevation unless indicated on the drawings and only then with proper provisions for draining and venting.
3. Provide 3/4 inch globe type drain valves fitted with 3/4 inch hose thread adapter at all low points of water piping systems or where indicated on drawings to permit complete or sectionalized draining.
4. Provide drip legs at low points and at the base of all risers in steam, plant air and gas lines. Unless otherwise shown, drip legs shall be full line sizes on lines through 4 inches and a minimum of 4 inches, but not less than half line size over 4 inches. Drip legs shall be a 12 inch minimum length, capped with a reducer to a 3/4 inch globe type drain valve.
5. Use eccentric reducing fittings on horizontal runs when changing size of lines in order to provide proper drainage and venting. Install steam, plant air, gas and gravity condensate lines with bottom of pipe and eccentric reducers in a continuous line; all other liquid lines with top of pipe and eccentric reducers in a continuous line.
6. Provide automatic air release valves at high points and wherever else required for elimination of air in all water and waste water solution piping systems. Valve discharge shall be piped to the floor.
7. All vent and drain piping shall be of same materials and construction as specified for the service involved unless specified or indicated otherwise.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

D. Sleeves and Plates:
   1. Provide sleeves for all pipes passing through floors, walls, partitions, slabs, grade beams and foundations.
   2. Lay out, size and locate all sleeves such that they are set and/or installed prior to pouring concrete or when masonry is being constructed. In the event sleeves must be placed after the floor, wall, grade beam, etc., has been constructed, submit in writing to the obtain approval from the Owner, quantity and proposed method of core drilling and installing. Cored openings must be clean and neat without cracking or spalling.
   3. Unless otherwise specified, sleeves shall be standard weight galvanized steel pipe having square cut ends with anchoring lugs welded on. Horizontal sleeves through walls, grade beams, foundations and partitions shall be flush with finished wall faces and have a water stop. Vertical Sleeves through floors shall extend 3 inches above finished floor and be flush on ceiling or under side.
   4. Size sleeves such that internal diameter is a minimum of 2 inches larger than OD of bare pipe for un-insulated lines and 2 inches larger than OD of insulation and jacket for insulated lines. Center pipes in sleeves. Sleeves in pits or below grade shall be painted or coated with one coat of coal tar pitch paint and have an integral waterstop.
   5. On lines passing through floors, slabs, walls, grade beams or foundations at or below grade and in pits, the annular space between outside of pipe or insulation and inside of sleeve shall be packed with oakum to within one inch of both sides and the remaining space filled with asphaltic mastic. On lines passing through walls and floors above grade, and annular space between outside of pipe or insulation and inside of sleeve shall be packed tight with fiberglass insulation.

E. Expansion, Anchoring, Guiding and Thrusting:
   1. Pipeline anchors and alignment guides shall be as required or as herein specified.
   2. Pipe expansion loops and offsets shall be provided as required.
   3. Alignment guides shall consist of a bolted semi-steel spider and a bolted guiding cylinder with supporting legs welded to the pipe support. Guides shall be as manufactured by Tube Turns Div., Allegheny Ludlum Industries, Louisville, Ky; Metraflex Co., Chicago, IL; or approved equal.

F. Underground Piping Protection:
   1. Direct, buried, un-insulated steel pipe shall be covered with T-1 Denso Tape as manufactured by Denso, Inc., Houston, TX, or approved equal.
   2. Approved alternate system suppliers are Pipe Line Service Co., Glenwillard, PA; Polyken Division of the Kendall Co., Boston, MA; Greenline Systems by Royston Laboratories, Pittsburgh, PA; Tapecoat Co., Evanston, IL; or approved equal.
   3. Flange bolts and nuts in pits and below ground shall be coated with Denso paste or as recommended by the alternate system manufacturer.

G. Indoor Piping Installation for Galvanized Steel Pipe:
   1. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Contract Drawings.
   2. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
4. Install piping at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
5. Install piping free of sags and bends.
6. Install fittings for changes in direction and branch connections.
7. Install escutcheons for penetrations of walls, ceilings, and floors.
    a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
    b. Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
    c. Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
    d. Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished chrome-plated finish.
    e. Piping in Equipment Rooms: One-piece, cast-brass type.
    f. Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
8. Verify final equipment locations for roughing-in.
9. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
10. Connect branch piping from top or side of horizontal piping.
11. Install unions in pipes NPS 2 (DN 50) and smaller at final connection to each piece of equipment and elsewhere as indicated. Unions are not required on flanged devices.

3.3 JOINING OF PIPES

A. General:
1. The joining of pipes shall be in accordance with the system acceptable and recommended by the manufacturer of the piping system. The joining methods herein described are a guide.
2. Threaded piping connections for plastic pipe are not to be used. In the connection of plastic pipe to a metal pipe, flanged connections shall be used.

B. Threaded Joints:
1. Pipe screw threads to conform to ANSI B2.1. Ream pipe ends and remove all burrs and chips after cutting and threading. Protect pipe thread during assembly. Apply thread lubricant to male threads as follows: John Crane Co., Morton Grove, IL, "Anti-Seize" for steam and condensate, boiler feed water and blow-down; read lead graphite for vent lines and roof conductor and Teflon tape for all other services, or approved equal.

C. Flanged Joints:
1. Steel pipe flanges shall conform to ANSI B16.5 "Steel Pipe Flanges and Flanged Fittings". Cast iron pipe flanges shall conform to ANSI B16.1 "Cast Iron Flanges and Flanged Fittings". Steel flanges shall be raised face except when bolted to flat face cast iron flange.
2. Flanged joints shall be made with bolts, bolt studs with nut on each end, or studs with nuts where the flange is tapped. The number and size of bolts shall conform to the same ANSI Standard as the flanges.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3. Bolting for services up to 500 degrees F shall be ANSI/ASTM A307 Grade B with square head bolts and heavy hexagonal nuts conforming to ANSI B18.2.1 "Square and Hex Bolts" and B18.2.2 "Square and Hex Nuts". Bolt studs and studs shall be of the same quality as machine bolts.
4. Set flange bolts beyond finger tightness with an indicating torque wrench to insure equal tension in all bolts. Tighten bolts such that those 180 degrees apart or directly opposite are torqued in sequence.

D. Mechanically Coupled Grooved Joints:
1. The entire installation, including pipe grooving, shall be accomplished in accordance with the manufacturer's published instructions. Final tightening of bolts shall be with a torque wrench to insure equal tension in all bolts.

E. Mechanically Coupled Plain End Joints:
1. Pipe preparation and assembly shall be in accordance with manufacturer's specifications. The assembly must be made with nuts tightened to the full torque requirements which depend on size.

F. Mechanical Joints:
1. Joints shall conform to ANSI A21.11 "Rubber Gasket Joints for Cast Iron Pressure Pipe and Fittings". Gasket material shall be Neoprene. The standard bolts and nuts of the pipe manufacturer shall be used and shall be coated at the factory with rust preventive lubricant after threading and tapping. Final tightening of bolts shall be with a torque wrench to insure equal tension in all bolts.

G. Flexible Connectors:
1. Flexible connectors shall be designed for the working pressures and temperatures required, and shall absorb vibration and eliminate sound transmission to the system. Minimum length of connectors shall be as recommended by the manufacturer for the size and pressure involved. Install connectors in accordance with the manufacturer’s recommendations. Support adjacent piping so connectors are not subjected to any piping weight or pipe expansion loads. The minimum pressure rating shall be 1800 psi.

H. Flexible Connectors for Low-Pressure Air Piping and Thermal Fluid Piping (Bellows Type):
1. General:
   a. Expansion connectors shall be furnished for installation at the locations shown on the Drawings.
   b. All expansion connections shall be selected and installed in accordance with the manufacturers’ recommendations.
   c. Where indicated on the Drawings, the expansion connectors shall be anchored with tie rods as recommended by the manufacturer, but in no case, when called for, shall there be less than two rods each.

3.4 PROCESS PIPING CLEANING

A. All water lines shall be flushed out under full treated water pressure; potable water piping shall be flushed with potable water; air piping shall be thoroughly blown out with air. All filters, control valves and gages shall be removed from lines or bypassed during the blowout period.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Following the blow-through, all dirt legs and other low points in lines shall be disassembled and all residual material thoroughly removed. All stop valves shall be removed and cleaned.

3.5 TESTING PREPARATION

A. The Contractor shall furnish all equipment and labor necessary to perform the field tests called for in this specification.

B. The Contractor shall give ample notice to the Owner that tests are to be conducted. The Owner or his Representative will witness the tests if he wishes.

C. No test shall be performed until all anchors, hangers, supports, test gages, plugs, bulkheads, blanks, etc., are installed. Tests shall be made against bulkheads or where permitted by the Owner.

D. Piping that connects to or is continuous with lines installed by others shall be isolated from such lines by valves or test blanks located at or near the junctions. When necessary to include parts of such lines in the test, the Owner's Representative shall be given prior notice so that test conditions may be mutually agreed upon.

E. When exposed piping is required to be painted or insulated, the paint or insulation shall not be applied to the pipe joints until the tests are completed.

F. Safety precautions shall be taken to prevent open ends of piping being in position to cause injury to personnel when blowing out or testing systems.

G. One or more calibrated indicating test gages shall be connected directly to the piping as necessary to coordinate the pressuring operation. The indicating gages shall be visible to the operator controlling the pressure. Pressure gages used shall have dials graduated over a range approximately 2 times the intended maximum test pressure.

3.6 TESTING METHODS

A. Pressure Pipelines - Liquid:
   1. All pressure pipelines conveying liquids and steam shall be tested by the Contractor in a manner satisfactory to and witnessed by the Owner's Representative.
      a. The section under test shall be filled with water; air expelled from the line and maintained full of water for a period of not less than 24 hours.
      b. The pressure and leakage test shall first consist of raising the water pressure (based on the elevation of the lowest point of the section under test and corrected to the gage elevation) to a pressure 1.5 times operating pressure and maintaining such pressure for a period of 30 minutes.
      c. The pressure and leakage test shall then consist of dropping the water pressure (based on the elevation of the lowest point of the section under test and corrected to the gage elevation) to a pressure of 1.2 times operating pressure. Such test shall be maintained for an additional 1-1/2 hours.
      d. For all pipelines not underground the section tested shall be considered as having failed to pass the test if the pressure test cannot be maintained without additional pumping.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

e. For all underground piping at the end of the test period for both the pressure test and the leakage test, the section tested will be accepted if the total leakage is not greater than that determined by the following formula:

$$L = \frac{ND(\sqrt{P})}{3700}$$

Where:
L = Allowable leakage in GPH
N = Number of joints in section tested
D = Nominal pipe diameter in inches
P = Average test pressure during test in psig

f. If the section fails to pass the pressure and leakage tests, the Contractor shall do everything necessary to locate, uncover and repair or replace the defective pipe, fitting, or joint, all at his own expense and without extension of time for completion of the work. Additional tests and repairs shall be made until the section passes the specified test.

B. Pressure Pipelines - Air:

1. All pressure pipelines conveying process air, flume air or primary air shall be tested by the Contractor in accordance with Division 33 Section "Testing of Pipelines and Hydraulic Structures".

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section gives the general requirements for the Contract 2 Process Instrumentation and Control (PIC). The proposed Contract 3 PIC system must be compatible with the Contract 2 system. If any deviations are proposed, prior approval must be given before an exception can be made. The following PIC subsections expand on requirements of this section:
   1. Division 40, Section 40 9100 "Instrumentation and Control Components".
   2. Division 40, Section 40 9443 "Programmable Logic Process Controllers".
   3. Division 40, Section 40 9500 "Process Control Hardware".
   4. Division 40, Section 40 9600 "Process Control Software".
   5. Division 40, Section 40 9990 "Package Control Systems".

B. Major Work Items: Includes but is not limited to engineering, furnishing, installing, calibrating, adjusting, testing, documenting, starting up, and training for complete PIC System**.**
   1. Process instrumentation including primary elements, transmitters, control devices, and control panels.
   2. Programmable Logic Controllers (PLC) and associated Input/Output (I/O) modules furnished and installed in control panels, completely wired, ready to run specified processes as specified.
      a. Where noted, subsystems are furnished as Ethernet connected package control systems with PLC hardware, configuration, and programming provided by package system suppliers.
   3. Provide a complete and operational PIC System. The PIC System consists of several plant PLC nodes and package system PLC nodes with provisions for future communication over a Fiber-Optic Ethernet/IP network. It is the responsibility of the PIC provider to include any ancillary components necessary to make this a complete functioning system.
   4. Standard and Applications Software:
      a. Provided by PICS for PLCs and HMIs.
      b. Provide software as shown and specified.
   5. Applications programming (AP) for a completely functioning and operational plant meeting the requirements outlined in the loop descriptions, for all specified AP packages.
   6. Control panels and field instruments to be furnished and listed in the Supplements of this section.
   7. All programming software and configuration programs shall become the property of the Owner.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1.3 REFERENCES

A. The following is a list of standards which may be referenced in this Section and other PIC subsections:
   1. American National Standards Institute (ANSI).
   2. ASTM International (ASTM):
      a. A182/A182M, Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
      b. A276, Standard Specification for Stainless Steel Bars and Shapes.
      c. A312/A312M, Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
      d. B32, Standard Specification for Solder Metal.
      e. B88, Standard Specification for Seamless Copper Water Tube.
   3. Institute of Electrical and Electronics Engineers, Inc. (IEEE): C62.41, Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
   4. The Instrument, Systems, and Automation Society (ISA):
      a. RP12.06.01, Recommended Practice for Wiring Methods for Hazardous (Classified) Locations Instrumentation Part 1: Intrinsic Safety.
      b. 85.1, Instrumentation Symbols and Identification.
      c. 85.4, Instrument Loop Diagrams.
      d. S50.1, Compatibility of Analog Signals for Electronic Industrial Process Instruments.
      e. TR20.00.01, Specification Forms for Process Measurement and Control Instruments, Part 1: General.
   5. International Conference on Energy Conversion and Application (ICECA).
   6. National Electrical Code (NEC).
   7. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
      b. ICS 1, Industrial Control and Systems General Requirements.
   8. National Fire Protection Association (NFPA): 820, Standard for Fire Protection in Wastewater Treatment and Collection Facilities.
   9. Underwriters Laboratory, Inc. (UL): 508A, Standard for Safety, Industrial Control Panels.

1.4 DEFINITIONS

A. Abbreviations:
   1. FDT: Factory Demonstration Test.
   2. HMI: Human-Machine Interface.
   3. HVAC: Heating, Ventilating, and Air Conditioning.
   4. I&C: Instrumentation and Control.
   5. I/O: Input and Output.
   6. OIU: Operator Interface Unit.
   7. O&M: Operation and Maintenance.
   8. PAT: Performance Acceptance Test.
   9. P&ID: Process and Instrumentation Diagram.
   10. PC: Personal Computer.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

11. PIC: Process Instrumentation and Control.
12. PLC: Programmable Logic Controller.
13. RIO: Remote I/O.
14. SCADA: Supervisory Control and Data Acquisition.

B. Enclosure: Control panel, console, cabinet, or instrument housing.

C. Instructor Day: Eight hours of actual instruction time.

D. Standard Software: Software packages that are independent of Project on which they are used. Standard software includes system software, and Supervisory Control and Data Acquisition (SCADA) software.
   1. System Software: Application independent (non-project specific) software developed by digital equipment manufacturers and software companies. Includes, but is not limited to, operating systems; network support, programming languages (C, C++, Visual C++, BASIC, Visual Basic, etc); Office Suites (word processor, spreadsheet, database, etc.); e-mail; security (firewall, antivirus, spam, spyware, etc.); debugging aids; and diagnostics.
   2. SCADA Software: Software packages independent of specific process control project on which they are used. Includes, but is not limited to, providing configuring and run-time capability for data acquisition (I/0 driver, OPC servers, etc.), monitoring, alarming, human-machine interface, supervisory control, data collection, data retrieval, trending, report generation, control, and diagnostics.
   3. Controller Programming Software: Software packages for the configuring of PLCs and fieldbus devices.
   4. Application Software: Software to provide functions unique to this Project and that are not provided by standard software alone, including but not limited to:
      a. Configuring databases, tables, displays, historians, reports, parameter lists, ladder logic, function block, and control strategies required to implement functions unique to this Project.
      b. Programming in any programming or scripting language.

E. Rising/Falling: Define action of discrete devices about their set point.
   1. Rising: Contacts close when an increasing process variable rises through set point.
   2. Falling: Contacts close when a decreasing process variable falls through set point.

F. Signal Types:
   1. Analog Signal, Current Type:
      a. 4 to 20 mA signals conforming to ISA S50.1.
      b. Unless otherwise indicated for specific PIC subsection components, use the following ISA S50.1 options:
         1) Transmitter Type: Number 2, two-wire.
         2) Transmitter Load Resistance Capacity: Class L.3 fully isolated transmitters and receivers.
   2. Analog Signal, Voltage Type: 1 to 5 volts DC within panel where common high precision dropping resistor is used.
   3. Discrete signals, two-state logic signals using 120V AC or 24V DC sources as required.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

4. Pulse Frequency Signals:
    a. Direct-current pulses whose repetition rate is linearly proportional to process variable.
    b. Pulses generated by contact closures or solid state switches.
    c. Power source less than 30V DC.
5. Special Signals: Other types of signals used to transmit analog and digital information between field elements, transmitters, receivers, controllers, and digital devices.

1.5 SUBMITTALS

A. General:
1. Furnish submittals in accordance with Division 01, Section "Submittal Procedures".
2. Partial submittals not in accordance with Project Schedule will not be accepted.
3. Submittal Format: hard copy required for all submittals.
4. Identify proposed items, options, installed spares, and other provisions for future work (for example, reserved panel space, unused components, wiring, and terminals).
5. Legends and Abbreviation Lists:
    a. Definition of symbols and abbreviations used; for example, engineering units, flowstreams, instruments, structures, and other process items used in nameplates, legends, data sheets, point descriptions, HMI displays, alarm/status logs, and reports.
    b. Use identical abbreviations in PIC subsections.
    c. Submit updated versions as they occur.
6. Activity Completion:
    a. Action Submittals: Completed when reviewed and approved.
    b. Informational Submittals: Completed when reviewed and found to meet conditions of the Contract.

B. Submittals:
1. Bill of Materials: List of required equipment.
    a. Group equipment items by enclosure and field, and within an enclosure, as follows:
        1) PIC Components: By component identification code.
        2) Other Equipment: By equipment type.
    b. Data Included:
        1) Equipment tag number.
        2) Description.
        3) Manufacturer, complete model number and all options not defined by model number.
        4) Quantity supplied.
        5) Component identification code where applicable.
        6) For panels, include panel reference number and name plate inscription.
    c. Submittals shall be grouped separately for each control panel.
2. Catalog Cuts: I&C components, electrical devices, and mechanical devices:
    a. Catalog information, marked to identify proposed items and options.
    b. Descriptive literature.
    c. External power and signal connections.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

d. Scaled drawings showing exterior dimensions and locations of electrical and mechanical interfaces.

3. Instrument List: Applicable fields to be completed include, but are not limited to:
   a. Instrument list characteristics item initially given by.
   b. Tag number engineer.
   c. Loop number engineer.
   d. Description
4. Component Data Sheets: Data sheets for I&C components.
   a. Group component data sheets according to the lAP Projects.
   b. Format: Similar to ISA TR2000.01.
   c. Content: Specific features and configuration data for each component, including, but not limited to:
      1) Tag Number.
      2) Component type identification code and description.
      3) Location or service.
      4) Service conditions.
      5) Manufacturer and complete model number.
      6) Size and scale range.
      7) Set points.
      8) Materials of construction.
      9) Options included.
      10) Power requirements.
      11) Signal interfaces.
5. Sizing and Selection Calculations:
   a. Primary Elements:
      1) Complete calculations plus process data used. Example for flow elements: minimum and maximum values, permanent head loss, and assumptions made.
   b. Controller, Computing, and Function Generating Modules: Actual scaling factors with units and how they were computed.
6. Preliminary Panel Elevation Drawings: Provide prior to submitting Panel Construction Drawings:
   a. Scale Drawings: Show dimensions and location of front of panel devices.
   b. Panel Legend (Bill of Material): List front of panel devices by tag number. Include nameplate inscriptions, service legends, and annunciator inscriptions.
7. Panel Construction Drawings:
   a. Scale Drawings: Show dimensions and locations of panel-mounted devices, doors, louvers, subpanels, internal and external.
   b. Panel Legend (Bill of Material): List front of panel devices by tag numbers, nameplate inscriptions, service legends, and annunciator inscriptions.
   c. Bill of Materials: List devices mounted within panel that are not listed in panel legend. Include tag number, description, manufacturer, and model number.
   d. Construction Details: NEMA rating, materials, material thickness, structural stiffeners and brackets, lifting lugs, mounting brackets and tabs, door hinges and latches, welding, and other connection callouts and details.
   e. Construction Notes: Finishes, wire color schemes, wire ratings, wire, terminal block numbering, and labeling scheme.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

8. Detailed Wiring Diagrams:
    a. Refer to Drawings for Detailed Wiring Diagrams including:
        1) Panel Wiring Diagrams for discrete control and power circuits.
        2) Loop Wiring Diagrams showing individual wiring diagram for each analog or pulse frequency loop.
        3) Interconnecting Wiring Diagrams showing electrical connections between equipment, consoles, panels, terminal junction boxes, and field-mounted components.
    b. Prepare as-built redline markup of detailed wiring diagrams. Show terminal numbers on switch blocks, relays, and internal components.
9. Panel Wiring Diagrams:
    a. Cover wiring within a panel including, but not limited to, instrumentation, control, power, communications, and digital networks.
    b. Objectives: For use in wiring panels, making panel connections, and future panel trouble-shooting.
    c. Diagram Type:
        1) Ladder diagrams where applicable. Include devices that are mounted in or on the panel that require electrical connections. Show unique rung numbers on left side of each rung.
        2) Schematic drawings for wiring of circuits that cannot be well represented by ladder diagrams.
    d. Item Identification: Identify each item with attributes listed.
        1) Wires: Wire number and color. Cable number if part of multiconductor cable.
        2) Terminals: Location (enclosure number, terminal junction box number, or MCC number), terminal strip number, and terminal block number.
        3) Components:
            a) Tag number, terminal numbers, and location ("FIELD", enclosure number, or MCC number).
            b) Switching action (open or close on rising or falling process variable), set point value and units, and process variable description (for example, Sump Level High).
        4) I/O Points: PLC or RIO unit number, I/O tag number, I/O address, terminal numbers, and terminal strip numbers.
        5) Relay Coils:
            a) Tag number and its function.
            b) On right side of rung where coil is located, list contact location by ladder number and sheet number. Underline normally closed contacts.
        6) Relay Contacts: Coil tag number, function, and coil location (ladder rung number and sheet number).
        7) Communications and Networks: Network type, address or node identification, port or channel number, and type of connector.
    e. Show each circuit individually. No "typical" diagrams or "typical" wire lists will be allowed.
    f. Ground wires, surge protectors, and connections.
    g. Wire and Cable Names: Show names and wire color for circuits entering and leaving a panel.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

10. Panel Power Requirements and Heat Dissipation:
    a. For control panels tabulate and summarize:
        1) Required voltages, currents, and phase(s).
        2) Maximum heat dissipations (Btu per hour).
        3) Steady State Temperature Calculations: For nonventilated panels, provide heat load calculations showing the estimated panel internal steady state temperature for ambient air temperatures of 95 degrees F. Include solar heating component.
11. Installation Details: Include modifications or further details required and define installation of I&C components.
12. Spares, expendables, and test equipment.
13. PLC I/O List: Submit I/O assignment and Rack/Slot/Point.
14. Color schedule for control panels.
15. Applications Software Documentation:
    a. Complete configuration documentation for microprocessor based programmable devices.
    b. For each device, include program listings and function block diagrams, as appropriate, showing:
        1) Functional blocks or modules used.
        2) Configuration, calibration, and tuning parameters.
        3) Descriptive annotations.
    c. Refer to PIC subsections for additional requirements.
16. List of spares, expendables, test equipment and tools provided.

C. Provide Manufacturer's Certificate of Proper Installation when necessary.

D. Testing Related Submittals:
1. Unwitnessed Factory Test: No Submittals Required.
2. Factory Demonstration Test:
    a. Proposed test procedures, forms, and checklists.
    b. Capacity, Timing, and Simulation: Describe simulation and monitoring methods used to demonstrate compliance with capacity and timing requirements.
    c. Submit a final test plan before scheduling a factory test.
    d. Test Documentation: Copy of signed off test results.
3. Functional Test:
    a. Preliminary Test Procedures: Outline of proposed tests, forms, and checklists.
    b. Final Test Procedures: Proposed test procedures, forms, and checklists.
    c. Test Documentation: Copy of signed-off test results.
    d. Owner Training Plan: In accordance with Division 01.

1.6 QUALITY ASSURANCE

A. Qualifications:
1. PIC System Integrator to demonstrate experience with the design, fabrication, supply and successful operation of instrumentation and control components. Experience to include integration, installation, and start-up of similar systems as required for this Project. Integrator may be asked to provide documented proof of experience.
2. PIC System Integrator's Site Representative to demonstrate experience with the design, fabrication, supply and successful operation of instrumentation and control components.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

Experience to include integration, installation, and start-up of similar systems as required for this Project. Site Representative may be asked to provide documented proof of experience.

3. PIC System Integrator shall coordinate with work being completed in Contract 2 - Wastewater Treatment Plant Improvements.

B. Acceptable Suppliers
   1. Single PIC System Supplier -- Provide the services of a single PIC System supplier to furnish, test, and commission the entire system. The PIC System supplier shall have the full in-house capabilities and personnel to design, fabricate, program, calibrate, start-up and trouble-shoot all control and instrumentation equipment without subcontracting or otherwise involving any temporary or non-staff personnel. A qualified electrical contractor will run conduit and pull wire and make all terminations for installations but check-out must be done by the PIC System supplier. Pre-approved PIC System suppliers are:
      a. Revere Control Systems, Birmingham, Alabama.
      b. Pre-approved equal (must be approved 2 weeks prior to original bid date).
   2. In order to ensure minimum down-time for any portion of the SCADA System, the SCADA System supplier shall provide service from a facility within a 100 mile radius of the project site.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Prior to shipment, include corrosive inhibitive vapor capsules in shipping containers, and related equipment as recommended by capsule manufacturer.

B. Prior to installation, store items in dry indoor locations. Provide heating in storage areas for items subject to corrosion under damp conditions.

C. Cover panels and other elements that are exposed to dusty construction environments.

1.8 SYSTEM DESCRIPTION

A. Design Requirements:
   1. Complete detailed design of PIC components and PIC drawings.
   2. Provide consistent hardware and software functions for PIC. For example, provide functions in control logic, sequence controls, and display layouts in same or similar manner.
   3. PIC design as shown and specified includes:
      a. Functional requirements, performance requirements, and component specifications.
      b. P&IDs, block diagrams, and network diagrams.
   4. Typical drawings for installation details, control panel layouts, control panel schedules, PLC I/O module wiring, panel power, and control diagrams.

B. Use a qualified PIC System Integrator for all work:
   1. For PIC Equipment and Ancillaries:
      a. Completing detail design.
      b. Submittals.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

c. Equipment, enclosures, and ancillaries.
d. Instructions, details, recommendations, and coordination with Contractor for Certificate of Proper Installation.
e. Verify readiness for operation.
f. Verify correctness of final power and signal connections (lugging and connecting).
g. Adjusting and calibrating.
h. Starting up.
i. Testing and coordination of testing.
j. Training.

2. Non-PIC Equipment Directly Connected to PIC Equipment:
   a. Obtain from Contractor manufacturers' information on installation, interface, function, and adjustment.
   b. Coordinate with Contractor to allow required interface and operation with PIC.
   c. For operation and control, verify that installations, interfacing signal terminations, and adjustments have been completed in accordance with manufacturer's recommendations.
   d. Test to demonstrate required interface and operation with PIC.
   e. Examples of items in this category, include, but are not limited to the following:
      1) Valve operators, position switches, and controls.
      2) Chemical feed pump and feeder speed/stroke controls.

1.9 EXTRA MATERIALS

A. Expendables: Provide manufacturer's recommended 2-year supply, unless otherwise noted. If items have a restricted shelf life, prepay and schedule delivery with manufacturer without Owner request.

PART 2 - PRODUCTS

2.1 GENERAL

A. Provide PIC functions shown on Drawings and required in PIC subsections for each system and loop. Furnish equipment items required in PIC subsections. Furnish materials, equipment, software, and programming necessary to effect required system and loop performance, whether indicated or not.

B. Like Equipment Items:
   1. Use products of one manufacturer and of the same series or family of models to achieve standardization for appearance, operation, maintenance, spare parts, and manufacturer's services.
   2. Implement same or similar functions in same or similar manner. For example: control logic, sequence controls, and display layouts.

2.2 PROGRAMMABLE LOGIC CONTROLLERS

A. Reference PLC components and specifications in Division 40 Section “Programmable Logic Process Controllers”.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Furnish all PLC and ancillary equipment that is necessary to achieve required performance. Refer to Loop Descriptions in Division 40 Section "Process Control Software" for additional performance requirements.

C. Cables: Provide all cables for interconnecting PLC components both inside individual panels and between panels or remote devices.

2.3 PLC I/O

A. Physical I/O points are shown on P&IDs and are included in the PLC Input/Output List in Division 40 Section "Programmable Logic Process Controllers" Supplements. This list is not all-inclusive. Provide any additional I/O functions or operations required to provide a completely operational system. Note that this list does not show the PLCs diagnostic fault detection points which are required. In cases of conflict between P&IDs and the PLC I/O lists, P&IDs take precedence.

B. Coordinate all I/O quantities and requirements with package system suppliers.

C. Provide each PLC with at least 15% installed spare I/O for each type used by that PLC or RIO rack.

D. Use the highest module capacity PLC chassis available before using an additional PLC chassis.

2.4 APPLICATIONS SOFTWARE AND PROGRAMMING

A. Provide applications software as specified for PLCs and as required meeting the functionality specified.
   1. Provide all applications software and drivers required for PLC programming.
   2. Provide all applications software and drivers required for PLC communication with HMIs and other PLCs at the Plant.

B. Provide applications software as specified for HMIs, computer workstations, and laptop computers, and as required to meet the functionality specified.

C. Provide all applications software and drivers required for SCADA programming.

D. Provide all applications software, drivers, and add-on packages to meet the functional requirements.

2.5 MECHANICAL SYSTEM COMPONENTS

A. Reference Division 40, Sections: all.

2.6 ELECTRICAL REQUIREMENTS

A. Reference Division 40, Sections: all.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2.7 PANEL FABRICATION

A. General:
   1. Nominal Panel Dimensions: Size control panels to include all PLC equipment, power supplies, relays, network switches, and fiber-optic transceivers.
   2. UL Listing Mark for Enclosures: Mark stating "Listed Enclosed Industrial Control Panel" per UL 508A.

B. Electrical Work: In accordance with the applicable requirements of Division 26, Electrical.

C. PIC Enclosure Internal Wiring:
   1. Restrain by plastic ties or ducts or metal raceways.
   2. Hinge Wiring: Secure at each end so that bending or twisting will be around longitudinal axis of wire. Protect bend area with sleeve.
   3. Arrange wiring neatly, cut to proper length, and remove surplus wire.
   4. Provide abrasion protection for wire bundles that pass through holes or across edges of sheet metal.
   5. Connections to Screw Type Terminals:
      a. Locking-fork-tongue or ring-tongue lugs.
      b. Use manufacturer's recommended tool with required sized anvil to make crimp lug terminations.
      c. Wires terminated in a crimp lug, maximum of one.
      d. Lugs installed on a screw terminal, maximum of two.
   6. Connections to Compression Clamp Type Terminals:
      a. Strip, prepare, and install wires in accordance with terminal manufacturer's recommendations.
      b. Wires installed in a compression screw and clamp, maximum of one for field wires entering enclosure, otherwise maximum of two.
      c. Terminate 24V DC and analog signal circuits on separate terminal block from AC circuit terminal blocks.
   7. Arrange wiring to allow access for testing, removal, and maintenance of circuits and components.
   8. Plastic Wire Duct Fill: Do not exceed manufacturer's recommendations.
   9. Provide a minimum of 1-1/2 inches between plastic wire ducts and terminal blocks.

PART 3 - EXECUTION

3.1 EXAMINATION

A. For equipment not provided by PIC System Integrator, but that directly interfaces with PIC, verify the following conditions:
   1. Proper installation.
   2. Calibration and adjustment of positioners and I/P transducers.
   3. Correct control action.
   4. Switch settings and dead bands.
   5. Opening and closing speeds and travel stops.
   6. Input and output signals.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3.2 INSTALLATION

A. Material and Equipment Installation: Follow manufacturers' installation instructions, unless otherwise indicated or directed by Engineer.

B. Wiring connected to PIC components and assemblies, including power wiring in accordance with requirements in Division 26.

3.3 FIELD QUALITY CONTROL

A. General:
   1. Coordinate PIC testing with Owner and affected Subcontractors.
   2. Notify Contactor of Performance Test schedule four (4) weeks prior to start of test.
   3. Engineer may actively participate in tests.
   4. Engineer reserves right to test or retest specified functions.
   5. Engineer's decision will be final regarding acceptability and completeness of testing.

B. Onsite Supervision:
   1. Require PIC System Integrator to observe PIC equipment installation to extent required in order to provide Certificates of Proper Installation.
   2. Require PIC site representative to supervise and coordinate onsite PIC activities.
   3. Require PIC site representative to be onsite while onsite work covered by this Section and PIC subsystems is in progress.

C. Testing:
   1. Prior to Facility Startup and Performance Evaluation period, inspect, test, and document that associated PIC equipment is ready for operation.

D. Performance Tests Prior to Facility Startup:
   1. Network Connected Package Systems Integration Testing:
      a. Fully test all functions including, but not limited to, control and monitoring functions of package systems, operator interface displays, historical data collection, alarm processing, reporting, and PLC peer communications.
   2. Operational Readiness Tests (ORTs):
      a. These tests are divided in two phases, Phase I and Phase II.
      b. Phase I ORTs shall verify all field instruments are calibrated and signal integrity from field devices to PLC I/O.
      c. Phase II ORT tests analog and digital I/O from field devices all the way to the HMI.

E. Performance Test During and After Facility Startup:
   1. Once the Functional Test has been completed and that facility has been started up, perform witnessed Performance Test on associated PIC equipment to demonstrate that it is operating as required by Contract Documents. Demonstrate each required function on a paragraph-by-paragraph, loop-by-loop, and site-by-site basis.
   2. Perform local and manual tests for each loop before proceeding to remote and automatic modes.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3. Make updated versions of documentation required for Performance Test available to Contractor at Site, both before and during tests.
4. Make O&M data available to Contractor at Site both before and during testing.

3.4 OPERATION AND MAINTENANCE MANUALS

A. Provide complete sets of separately bound Operation and Maintenance Manuals for each subsection of the SCADA System as required in Division 01, Section 01 7823 "Operation and Maintenance Data".

B. These manuals shall include operating and maintenance information for all subsections (and their components) provided in this section. The O&M information shall be in sufficient detail to allow the operation, removal, installation, adjustment, calibration, and maintenance of each component provided under this section to the printed circuit board level.

C. Each manual shall include a legend and abbreviation list.

D. Each set of manuals for each subsection shall be assembled in one or more 3-ring binders; each with a title page, table of contents, and heavy section dividers with labeled index tabs. Where more than one binder is required, the binders shall be labeled “Volume 1", “Volume 2", etc. The table of contents shall encompass the entire set of O&M Manuals, shall list the contents of each volume and shall appear in each binder.

E. Operational Readiness Test Component and I/O Module Calibration Sheets shall be included as part of the Analog Subsection O&M Manual sets.

3.5 TRAINING

A. General:
   1. Provide an integrated training program for Owner's personnel.
   2. Perform training to meet specific needs of Owner's personnel.
   3. Include training sessions, classroom and field, for managers, engineers, operators, and maintenance personnel.
   4. Provide instruction on one working shift as needed to accommodate the Owner's personnel schedule.
   5. Owner reserves the right to reuse videotapes of training sessions.

B. Operations and Maintenance Training:
   1. General:
      a. Include review of O&M data and survey of spares, expendables, and test equipment.
      b. Use equipment similar to that provided.
   2. Operations Training: For Owner's operations personnel on operation of I&C components.
      a. Training Session Duration: One (1) instructor day.
      b. Number of Training Sessions: One (1).
      c. Location: Project Site.
      d. Course Objective: Develop skills needed to use I&C components and functions to monitor and control the plant on a day-to-day basis.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3. Maintenance Training:
    a. Training Session Duration: Two (2) instructor days.
    b. Number of Training Sessions: One (1).
    c. Location: Project Site.
    d. Course Objective: Develop skills needed for routine maintenance of PIC.
    e. Content: Provide training for each type of component and function provided.
        1) Loop Functions: Understanding details of each loop and how they function.
        2) Component calibration.
        3) Adjustments: For example, controller tuning constants, current switch trip points, and similar items.
        4) Troubleshooting and diagnosis for equipment and software.
        5) Replacing lamps, chart paper, and fuses.
        6) I&C components removal and replacement.
        7) Periodic preventive maintenance.

3.6 CLEANING

A. Upon completion of Work, remove materials, scraps, and debris from interior and exterior of equipment.

B. After all work in panels is complete:
    1. Replace all wireway covers and complete final dress-out of wiring inside and outside wireways.
    2. Use cable ties and other methods to restrain and manage wiring and cable bundles.
    3. Remove all debris and unused components.
    4. Clean out each panel using a vacuum cleaner to remove dust, fillings, and other debris too small to remove otherwise.

3.7 PROTECTION

A. Use corrosion-inhibiting vapor capsules in enclosures to protect electrical, instrumentation, and control devices, including spare parts, from corrosion.

B. Periodically replace capsules based on capsule manufacturer's recommendations.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This section gives general requirements for instrumentation and control components.

1.3 SUBMITTALS

A. Furnish submittals in accordance with Division 01, Section “Submittal Procedures”.

B. Product Data:
   1. Include information on all test equipment.
   2. Manufacturer's operation and installation instructions.

C. Shop Drawings:
   1. Complete set of drawings including, but not limited to:
      a. System block diagram showing relationship and connections between devices provided under this Contract. Include manufacturer and model information and address settings.
      b. Network riser diagram.
      c. Network port diagram, which physically locates all ports within the facility and identifies their patch panel and switch port.
      d. Construction drawings for all equipment cabinets, including dimensions, identification of all components, preparation and finish data, and nameplates.
      e. Electrical connection diagrams.
      f. Complete grounding requirements.

D. Furnish data sheets for each component together with a technical product brochure or bulletin:
   1. Manufacturer's model number.
   2. Project equipment tag.

E. Complete and detailed bills of materials broken up by each cabinet. Each bill of material item will include the following:
   1. Quantity.
   2. Description.
   3. Manufacturer.
   4. Part numbers.

F. Test Reports:
   1. Signed test results as described in Part 3 of this Section.
   2. Test results shall include:
      a. Narrative describing the test procedures followed.
      b. Block diagram of test set-up.
      c. Manufacturer's information on test equipment used.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

d. Detailed test results.
e. A narrative summarizing the results of the testing and identifying any further action required.

G. Operating Manuals:
1. Complete installation, operation, calibration, and testing manuals as described in Division 01, Section "Operation and Maintenance Data".

H. Record Drawings:
1. Electrical connection diagrams shall be revised to reflect any changes made in the field and submitted as record drawings.

1.4 DELIVERY, STORAGE AND HANDLING

A. Protect components against damage according to the manufacturer's recommendations.

1.5 WARRANTIES AND BONDS

A. Provide a warranty against defective or deficient materials and workmanship in accordance with the requirements of Division 01 Section "Closeout Procedures".

B. The equipment manufacturer shall provide a warranty against defective or deficient equipment, workmanship and materials under normal use, operation and service. The warranty shall end a minimum of one year from the date of Substantial Completion. The warranty shall be in printed form and apply to all similar units.

PART 2 - PRODUCTS

2.1 GENERAL

A. Article Mechanical Systems Components covers requirements of mechanical components that are not specifically referenced by Division 40 Sections.

B. Article Electrical Components covers requirements for electrical components that are not specifically referenced by Division 40 Sections.

C. All other Part 2 articles are also given as a minimum quality requirement for all instruments and components provided by package systems suppliers in addition to the requirements of Division 40 Sections.

2.2 MECHANICAL SYSTEMS COMPONENTS

A. Manifold, Two-Valve:
1. Type: For block and bleed of gauge pressure transmitter.
2. Materials: Type 316 SST.

B. Manifold, Three-Valve Equalizing:
1. Type: For isolation and equalization of differential pressure transducers.
2. Materials: Stainless steel.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

C. Valve, Needle:
   1. Materials: Brass, stainless steel, PVC, or CPCV, as recommended by manufacturer for designated service, unless otherwise shown on drawings.
   2. Size: 0.020-inch orifice.
   3. Manufacturers and Products:
      a. Whitey, Model 21RF2.
      b. Hoke; 3700 Series.
      c. Or approved equal.

D. Solenoid Valve, Two-Way:
   1. Type: Globe valve directly actuated by solenoid and not requiring minimum pressure differential for operation. Rated for continuous duty with manual over-ride option.
   2. Materials:
      a. Body: Type 316 stainless steel globe valves as recommended by manufacturer for designated service, unless otherwise shown on drawings.
      b. Valve Seat: Buna-N.
   3. Size: Normally closed.
   4. Coil: 115V AC, unless noted otherwise.
   5. Solenoid Enclosure: NEMA 4X, Type 316 stainless steel.
   6. Manufacturer and Product: ASCO, Red Hat Series 8260 or approved equal.

E. Plastic Tubing and Fittings:
   1. Tubing:
      a. Polyethylene capable of withstanding 190 psig at 175 degrees F.
      b. Manufacturers and Products:
         1) Dekoron; Type P.
         2) Imperial Eastman; Poly-Flo black instrument tubing.
         3) Or approved equal.
   2. Fittings:
      a. Type: Brass compression.
      b. Manufacturers and Products:
         1) Imperial Eastman; Poly-Flo tube fittings.
         2) Dekoron; E-Z fittings. P. Stainless Steel Tubing: ASTM A312/A312M, Type 316, 0.065-inch wall, seamless, soft annealed, as shown on drawings.
         3) Or approved equal.

F. Stainless Steel Fittings:
   1. Compression Type:
      a. Materials: Type 316 stainless steel, ASTM A182/A182M forged bodies or ASTM A276 barstock bodies, flareless.
      b. Manufacturers and Products:
         1) Parker Flodar; BA Series.
         2) Swagelok tube fittings.
         3) Parker CPI tube fittings; Parker A-LOK dual ferrule tube fittings.
         4) Or approved equal.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2. Socket Weld Type:
   a. Materials: Type 316 stainless steel, ASTM A182/A182M forged bodies or ASTM A276 barstock bodies, 3,000 psi maximum working pressure, safety factor 4:1.
   b. Manufacturers:
      1) Cajon.
      2) Swagelok.
      3) Parker WELDLOK.
      4) Or approved equal.

2.3 ANALYTICAL COMPONENTS

A. Oxygen and Carbon Monoxide Analyzers
1. Provide two (2) gas detection systems that shall continuously measure and display the concentrations of two different gases, as follows:

   Oxygen; 0 – 25% by volume
   Carbon Monoxide; 0 – 100 ppm

   a. The gas detection system shall be a self-contained unit within a single, NEMA 4X Stainless Steel enclosure with heater.
   b. The gas monitor shall be located in non-classified area.
   c. The display of the Two (2) gases shall be visible through the front of the enclosure.
2. Feature – The standard gas detection system shall include the following features:
   a. Internal DC sample pump
   b. 120 VAC power
   c. Three Alarm relays SPST and one Trouble relay SPDT
   d. Relays rated at 5 amps @ 120 VAC/30 VDC non-inductive
   e. Analog 4 – 20 mA output per sensor
   f. AC to DC power supply
   g. Flashback arrestor for LEL sensor, if required.
   h. End of line Hydrophobic filter
3. The standard sensor features shall include:
   a. Over LEL protection
   b. Over range protection
   c. Local display
   d. Automatic adjustments for calibration
   e. Date of last calibration
   f. Changeable under power
4. The standard pump features shall include:
   a. Built-in flow switch
   b. Fault indicator
   c. Fault relay, rated at 5 amps
   d. Sample draw capability up to 100 feet
5. Calibration – Calibration of the gas detection system shall be accomplished by applying gas to the sensors via a three-way pushbutton located on the outside of the enclosure.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

Calibration of the sensors shall be initiated using an infrared calibration unit transmitting a calibration signal through the face of the gas detection system enclosure. A one year supply of calibration gases shall be supplied at a minimum.

a. A hand held Calibration Controller shall be provided to allow for calibration and adjusting of all settings. The use of magnets is not permissible.

6. Optional Accessories, if required
   a. Unit-mounted Red Strobe
   b. Unit-mounted Red and Yellow Strobe
   c. Federal horn with silence push button
   d. Adding a third sensor, if required
7. All sample tubing exposed to outdoor temperature shall be heat traced as recommended by manufacture.
8. Manufacturer Capability Requirements - As a minimum, the Gas Monitoring Equipment manufacturer must meet the following requirements.
   a. The manufacturer must be capable of supplying all equipment used to check or calibrate the sensor/transmitter units.
   b. The manufacturer must be capable of providing on site service with factory trained personnel.
   c. The manufacturer must be capable of providing on site training for owner/operator.
9. The gas detection system shall be a MSA TRIGAS Ultima X Series Gas Monitor System or approved equal.

2.4 LEVEL COMPONENTS

A. Level Element and Transmitter, Ultrasonic:
   1. General:
      a. Function: Continuous, noncontacting level measurement.
      b. Type: Ultrasonic.
      c. Parts: Element, transmitter, and interconnecting cable between element and transmitter.
   2. Service:
      a. Vapor Space Pressure: Atmospheric, unless otherwise noted.
      b. Operating Temperature Range:
         1) Element: -40 to +150 degrees F.
         2) Transmitter: -5 to +122 degrees F.
   3. Performance:
      a. Range: As noted.
      b. Zero Reference: As noted.
      c. Accuracy: $\pm$ 0.25 percent of maximum range or 6 mm, whichever is greater.
      d. Resolution: 2 mm or 0.1 percent of range, whichever is greater.
      e. Blanking Distance: As short as 1 foot.
   4. Element:
      a. Waterproof/weatherproof.
      b. Housing: Kynar, PVC, or Valox 357, unless otherwise noted.
      c. Face: Kynar, Teflon, or Valox 357, unless otherwise noted.
      d. Process Connection: 1-inch NPT, unless otherwise noted.
      e. Electrically Hazardous Rating: Unrated, unless otherwise noted.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

f. Beam Angle: 12 degrees or less.
g. Integral temperature compensation.
h. Sound Wave Frequency: 44 kHz, typical.

5. Transmitter:
   a. Primary Configuration: Microprocessor based with keyboard operator interface.
   b. Secondary Configuration: Windows Based Configuration Software.
   c. Enclosure: NEMA 4X polycarbonate, unless otherwise noted.
   d. Power Supply: 115-volt, 50/60-Hz, unless otherwise noted.
   e. Isolated Analog Output:
      1) One, minimum, Milliamp current loop for load impedance of 0 to 750 ohms.
      2) Milliamp current loop programmable as 4-20, 0-20, 20-4, or 20-0 mA.
   f. Digital Communication: As noted.
   g. Other Features: As noted.
   h. Discrete Outputs: Minimum, five relays (combination of SPST and SPDT) rated for 5 amps continuous at 120V AC.
   i. Display:
      1) Multifield LCD.
      2) High contrast 40 mm (1.5 inches).
      3) In standard engineering units (feet, inches, or centimeters); volumetric conversion.
      4) Alarm Messages: Loss of echo and cable circuit open or shorted.
   j. Filters, Electronic:
      1) For agitator blade echoes.
      2) To remove small variations from surface waves.
      3) Narrow echo and spike filters to remove spurious readings from noise sources such as variable frequency drives.
   k. Where indicated on the instrument lists, this instrument will be used in open channel flow measurement application. For flow applications, provide characterizing module to convert level of flow.
6. Interconnecting Cable: Weatherproof, UV protected, length as required, and type as recommended by manufacturer.
7. Manufacturers and Products: Endress and Hauser or approved equal.

B. Level Switch, Float:
   1. General:
      a. Function: Actuate contact at preset liquid level.
      b. Type: Direct-acting float with magnet actuated sealed reed switch or SPDT switches actuated by Karbate Displacers.
   2. Service (Liquid): Wastewater, unless otherwise noted.
   3. Performance:
      a. Set Point: As noted.
      b. Differential: 1-inch maximum.
      c. Temperature: 32 to 160 degrees F.
   4. Features:
      a. Entire Assembly: Watertight and impact-resistant.
      b. Float Material and Size: Teflon coated body; 4.5-inch diameter and 6-inch length.
      c. Cable:

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1) Combination support and signal.
2) Length as noted or as necessary per mounting requirements.
3) PVC Type STO, two #18AWG.

d. Mounting: Pipe or Suspended with Anchor, unless otherwise noted.
1) Pipe:
a) Cable-to-pipe clamp, corrosion-proof cable for 1-inch pipe.
b) Pipe-to-wall bracket for 1-inch pipe.
2) Suspended Type: Suspended cable shall be Type 316 stainless steel.

5. Signal Interface:
a. Switch Type: Mercury tilt.
b. Switch Contacts:
1) Isolated, rated 4.5A continuous at 120V AC.
2) Form C-type contact (1 NO, 1 NC).

6. Accessories:
a. Intrinsic Safety Barriers: If noted.
b. TCB Junction Box (for four switches and ground lug): If noted.

7. Manufacturers and Products:
a. USFilter Control Systems; Model LS Direct Acting Float Switch (B100).
b. Anchor Scientific; Roto-Float, Type P/Type S.
c. Or approved equal.

2.5 TEMPERATURE COMPONENTS

A. RTDS:
1. Design and Fabrication:
a. 100 ohms @ 0 deg. C.;
b. Spring loaded;
c. Lead Wire Compensation: 3-wire;
d. Accuracy: 0.5 deg F.;
e. Sheath Diameter: 1/4-inch; and
f. Sheath Length: 9 inch.

2. Materials:
a. Sensor shall be platinum.
b. Sheath shall be 316 stainless steel.
c. Insulation shall be ceramic or metallic oxide.

3. Acceptable Manufacturers:
a. Burns Engineering.
b. Rosemount.
c. Or approved equal.

B. Thermowells:
1. Materials:
a. Well material shall be 316 stainless steel.
b. Immersion length shall be 4 inches.
c. Process connection shall be 1/2-inch NPT.
d. Contractor shall be responsible for any piping tees required for proper insertion length.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2. Acceptable Manufacturers:
   a. Burns Engineering.
   b. Rosemount.
   c. Or approved equal.

C. Temperature Transmitters:
1. Design and Fabrication:
   a. Transmitter must use microprocessor-based electronics;
   b. Input Type: RTD;
   c. Temperature Rating: -40 to 185 deg. F.;
   d. Output: 4-20 mA; and
   e. Supply Power: 24V DC.
2. Materials: Mounting head shall be weatherproof aluminum.
3. Acceptable Manufacturers:
   a. Burns Engineering.
   b. Rosemount.
   c. Or approved equal.

2.6 PRESSURE COMPONENTS

A. Pressure Gauge, Small Dial:
1. General:
   a. Function: Pressure indication.
   b. Type: Bourdon tube.
2. Performance:
   a. Scale Range: As noted.
   b. Accuracy: ± 1.0 percent of full scale.
3. Features:
   a. Liquid Filled (Glycerin).
   b. Dial: 2-1/2-inch diameter, unless otherwise noted.
   c. Case Material: Type 316 stainless steel.
   d. Element Material: Type 316 stainless steel, unless otherwise noted.
   e. Pointer: Aluminum.
   f. Movement: Stainless steel, nylon coated bearings, rotary geared.
   g. Window: Polycarbonate, unless otherwise noted.
   h. Socket Materials: Stainless steel, unless otherwise noted.
4. Process Connection:
   a. Mounting: Lower stem, unless otherwise noted.
   b. Size: 1/4-inch, unless otherwise noted.
   c. Connection Type: Threaded (NPT).
5. Manufacturers and Products:
   a. Ashcroft; Model 1279.
   b. Ametek; Solfrunt Series 1900.
   c. Or approved equal

B. Pressure Seal, Diaphragm:
1. General;
   a. Function: Isolate sensing element from process fluid.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

b. Type:
1) Diaphragm.
2) Fluid filled between diaphragm and sensing element.

2. Service:
a. Pressure: Same as associated sensor.
b. Temperature Range: If noted.

3. Performance:
a. Pressure:
1) For threaded process connections, at least 2,500 psig at 100 degrees F.
b. Temperature:
1) Dependent upon fill fluid.
a) Silicone: -40 degrees F to 600 degrees F.
b) Halocarbon: -70 degrees F to 300 degrees F.

4. Features:
a. Materials:
1) Lower Housing: Type 316 stainless steel, unless otherwise noted.
2) Diaphragm Material: Type 316 stainless steel, unless otherwise noted.
3) Top Housing: Steel, unless otherwise noted.
b. Diaphragm: Welded to upper housing, unless otherwise noted.
c. Filling screw in upper housing.
d. Fill Fluid:
1) Silicone, unless otherwise noted.
2) Factory assembled and filled.
e. Flushing Connection: 1/4-inch NPT in lower housing.
f. Diaphragm Seal Displacement: 0.1 cubic inch, nominal.

5. Connections:
a. Instrument: 1/2-inch female NPT, unless otherwise noted.
b. Process: 1/2-inch female NPT, unless otherwise noted.

6. Manufacturers:
a. Ashcroft; Type 201.
b. Ametek: Mansfield and Green Division; Type SG.
c. WIKA; Type L990.10.
d. Or approved equal.

C. Pressure Switch, Adjustable Dead Band:

1. General:
a. Function: Monitor pressure, activate switch at set point, and deactivate switch at reset point.
b. Type:
1) Piston-actuated.
2) Both set point and dead band (the differential between set point and reset point) adjustable.

2. Performance:
a. Set Point:
1) As noted.
2) Repeatability: $\pm$ 1 percent of range.
b. Reset Point: As noted.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

c. Range: The noted set point shall fall between 20 percent and 80 percent of the range.
d. Dead band: Adjustable within nominally 25 percent and 85 percent of range.
e. Overpressure Proof Pressure:
1) Pressure psi Ranges: At least 400 percent of rated maximum static pressure.
2) Pressure Inches of Water Ranges: 20 psig.
3) Compound Range: 250 psig.
4) Vacuum Range: 250 psig.
f. Operating Temperature Range:
1) Dependent on actuator seal materials.
2) For Buna-N seal, 0 degrees F to 150 degrees F.

3. Features:
a. Actuator Seal: Buna-N, unless otherwise noted.
b. Adjustable dead band.
c. Mounting: Surface, unless otherwise noted.

4. Process Connection:
a. 1/4-inch NPT female connections, unless otherwise noted.
b. Materials:
1) Pressure psi Ranges: Type 316 stainless steel, unless otherwise noted.
2) Pressure Inches of Water Ranges: Epoxy coated carbon steel, unless otherwise noted.

5. Enclosure: NEMA 4X, unless otherwise noted.

6. Signal Interface:
a. Contact Type:
1) SPDT.
2) Rated for 10 amps minimum at 120V AC.
b. Hermetically Sealed Switch: If noted.

7. Manufacturers and Products:
a. Ashcroft; L or P Series.
b. United Electric; J6 Series.
c. Or approved equal.

D. Pressure Transmitter:
1. General:
a. Function: Measure pressure and transmit signal proportional to pressure.
b. Type:
1) Electronic variable capacitance or silicon strain gauge.
2) Two-wire transmitter; "smart electronics".
c. Parts: Transmitter and accessories. Provide diaphragm seal.

2. Performance:
a. Range: As noted.
1) Select transmitter's factory upper range limit (URL) such that upper boundary of noted range is as close as possible to 80 percent of factory URL, but does not exceed it.
b. Accuracy: $\pm$ 0.075 percent of span, unless otherwise noted.
c. Ambient Operating Temperature: -40 degrees F to 175 degrees F, with integral meter.
d. Process Operating Temperature: 0 degrees F to plus 250 degrees F.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

e. Humidity: 0 to 100 percent relative humidity.
f. Hazardous Location Certifications: If and as noted.

3. Features:
   a. Type: Gauge pressure, unless otherwise noted.
   b. Adjustable damping.
   c. LCD indicator, unless otherwise noted.
      1) Display in either percent or engineering units, field configurable.
   d. Wetted Metallic Parts: Type 316 stainless steel, unless otherwise noted.
      1) Includes drain/vent valves, process flanges and adapters, and process isolating diaphragm.
   e. Wetted O-Rings: Glass filled TFE, graphite filled PTFE, or Viton, unless otherwise noted.
   f. Bolts and Nuts: Type 316 stainless steel, unless otherwise noted.
   g. Fill Fluid: Silicone, unless otherwise noted.
4. Process Connections:
   a. Line Size: 1/2 inch.
   b. Connection Type: FNPT.
   c. Direct/remote Diaphragm Seal: If and as noted.
5. Signal Interface:
   a. 4-20 mA DC output with digital signal based on HART protocol, unless otherwise noted below.
      1) Nominal Maximum Loop Resistance with External 24V DC Power Supply: 550 ohms.
6. Enclosure:
   a. Type: NEMA 4X.
   b. Materials: Coated aluminum, unless otherwise noted.
   c. Mounting bracket, unless otherwise noted.
   d. Bracket and Accessories: Stainless steel; suitable for mounting transmitter to panel or 2-inch pipe.
7. Accessories:
   a. Two-valve (isolate and vent) Stainless Steel Manifold for each pressure transmitter as shown on the Drawings.
8. Manufacturers and Products:
   a. Gauge Pressure Units:
      1) Endress and Hauser; Deltabar S PMD/FMD 75 Series.
      2) Or approved equal.

2.7 FLOW COMPONENTS

A. Flow Element and Transmitter, Electromagnetic:
1. General:
   a. Function: Measure, indicate, and transmit the flow of a conductive process liquid in a full pipe.
   b. Type:
      1) Electromagnetic flowmeter, with operation based on Faraday's Law, utilizing the pulsed DC type coil excitation principle with high impedance electrodes.
      2) Full bore meter with magnetic field traversing entire flow-tube cross section.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3) Insert magmeters or multiple single point probes inserted into a spool piece are unacceptable.

c. Parts: Flow element, transmitter, interconnecting cables, and mounting hardware. Other parts as noted.

2. Service:
   a. Stream Fluid:
      1) As noted.
      2) Suitable for liquids with a minimum conductivity of 5 microS/cm and for demineralized water with a minimum conductivity of 20 microS/cm.
   b. Flow Stream Descriptions: If and as described below.
3. Operating Temperature:
   a. Element:
      1) Ambient: -5 to 140 degrees F, typical, unless otherwise noted.
      2) Process: -5 to 140 degrees F, typical, unless otherwise noted.
   b. Transmitter:
      1) Ambient: -5 to 140 degrees F, typical, unless otherwise noted.
4. Performance:
   a. Flow Range: As noted.
   b. Accuracy: ±0.5 percent of rate for all flows resulting from pipe velocities of 2 to 30 feet per second.
   c. Turndown Ratio: Minimum of 10 to 1 when flow velocity at minimum flow is at least 1 foot per second.
5. Features:
   a. Zero stability feature to eliminate the need to stop flow to check zero alignment.
   b. No obstructions to flow.
   c. Very low pressure loss.
   d. Measures bi-directional flow.
6. Process Connection:
   a. Meter Size (diameter inches): As noted.
   b. Connection Type: 150-pound ANSI raised-face flanges; AWWA C207, Table 2 Class D; or wafer style depending on meter size, unless otherwise noted.
   c. Flange Material: Carbon steel, unless otherwise noted.
7. Power (Transmitter): 120V AC, 60-Hz, unless otherwise noted.
8. Element:
   a. Meter Tube Material: Type 316 stainless steel body and flanges, unless otherwise noted.
   b. Liner Material:
      1) Teflon or Hard Rubber, unless otherwise noted.
      2) For potable water service, must have appropriate approvals.
   c. Liner Protectors: Covers (or grounding rings) on each end to protect liner during shipment.
   d. Electrode Type: Flush or bullet nose as recommended by the manufacturer for the noted stream fluid.
   e. Electrode Material: Hastelloy C, unless otherwise noted.
   f. Grounding Ring:
      1) Required, unless otherwise noted.
      2) Quantity: Two, unless otherwise noted.
      3) Material: Type 316 stainless steel, unless otherwise noted.
   g. Enclosure: NEMA 4X, minimum, unless otherwise noted.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

9. Transmitter:
    a. Mounting: Surface (wall), remote mount.
    b. Display: Required.
        1) Digital LCD display, indicating flow rate and total.
        2) Bi-directional Flow Display: Required, unless otherwise noted.
            a) Forward and reverse flow rate.
            b) Forward, reverse, and net totalization.
    c. Parameter adjustments: By keypad or non-intrusive means.
    d. Enclosure: NEMA 4X, minimum, furnished with sunshield for outdoor installations.
10. Signal Interface (at Transmitter):
    a. Analog Output:
        1) Isolated 4 mA to 20 mA for load impedance from 0 ohm to at least 500 ohms minimum for 24V DC supply.
    b. Discrete Outputs: If noted.
        1) Two discrete outputs, rated for up to 30 volts, typical.
        2) Programmable as noted for the following typical parameters:
            a) High/low flow rates, percent of range, empty pipe zero, fault conditions, forward/reverse, etc.
    c. Discrete Input: If noted.
        1) Contact closure, configured as noted for the following typical parameters: reset totalizer, change range, hold output constant, drive output to zero, and low flow cutoff, etc.
11. Cables
    a. Types: As recommended by manufacturer.
    b. Lengths: As required to accommodate device locations.
12. Built-in Diagnostic System:
    a. Features:
        1) Field programmable electronics.
        2) Self-diagnostics with troubleshooting codes.
        3) Ability to program electronics with full scale flow, engineering units, meter size, zero flow cutoff, desired signal damping, totalizer unit digit value, etc.
        4) Initial flow tube calibration and subsequent calibration checks.
13. Factory Calibration:
    a. Calibrated in an ISO 9001 and NIST certified factory.
    b. Factory flow calibration system must be certified by volume or weight certified calibration devices.
    c. Factory flow calibration system shall be able to maintain calibration flow rate for at least 5 minutes for repeatability point checks.
14. Manufacturers:
    a. Endress & Hauser, Inc. Flow Measuring System: Promag 50/53W (size: 1 to 78 inches).
    b. ABB Automation: MagMaster (includes Transmitter); MFE or MFF Series.
    c. Or approved equal.

B. Flow Element and Transmitter, Natural Gas:

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1. The flowmeter shall operate on the Constant Delta Temperature (Constant Delta T) thermal mass principal. The sensing elements shall consist of two platinum RTD's. The sensor's heated element shall operate a constant temperature of 100oF above the gas temperature.
2. The flowmeter shall have a built-in display of flow rate, flow total, temperature, and elapse time. The readout shall utilize a backlit LCD display consisting of two lines each 16 characters. Two 4 to 20mA outputs (one for flow rate, one for gas temperature) and one pulse output will be included. The electronic display shallbe remote from the meter for surface (wall) mounting at an accessible level.
3. A 4-key keypad will be employed for user programming. Input parameters shall be protected by use of a password. Nonvolatile memory will retain totalizer and user parameters for up to seven (7) years.
4. The flowmeter shall have a built-in microprocessor allowing field programmability of the 4 mA setting, 20 mA setting, pulse output setting, pipe/duct area, zero flow cutoff and alarm settings.
5. The flowmeter shall measure gas flows over a range of 0 - 32,000 standard feet per minute. Sensor response time shall be 0.9 seconds for a one (1) Sigma change in velocity.
6. Accuracy shall be ±1.0 percent of reading plus 0.2 percent of full scale and repeatability ±0.2 percent of full scale over an operating temperature range of -40F to +250F.
7. All wetted parts are to be 316SS utilizing an all welded design.
8. All electronics to be mounted in a single NEMA 4X enclosure. Input power will be 24 VDC or 85 to 250 VAC, 50/60 Hz.
9. Communications shall be via Ethernet using Allen Bradley protocol.
10. The manufacturer shall provide an NIST traceable calibration certificate for the instrument.
11. The meter will have internal self-diagnostics without requiring external equipment to evaluate meter performance.
12. The Instrument shall be Model FT2-40F-SS-ST-E3-DD-BO-G3, manufactured by Fox Thermal Instruments, Inc., of Marina, California, or approved equal.

2.8 SECONDARY COMPONENTS

A. Isolator, Current:
   1. General:
      a. Function: Isolate an analog current signal.
      b. Type:
         1) Solid state with external power supply.
         2) Three-way isolation of the input signal, output signal, and external power supply.
      c. Parts: Isolator plus DIN rail strip.
   2. Performance:
      a. Isolation:
         1) Three-way isolation between input, output, and power circuits for common mode voltages up to 250V AC, or 354V DC of ground, on a continuous basis.
         2) Able to withstand 1500 VAC dielectric strength test for 60 seconds without breakdown.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

b. Output Ripple: Less than ± 0.1 percent of maximum output span.
c. Accuracy: ± 0.1 percent of output span.
d. RFI Resistance: Less than ± 0.5 percent of output span with RFI field strengths of up to 10V/meter at frequencies of 27, 151, and 467 MHz.
e. EMI resistance: Less than ± 0.25 percent of output span effect with switching solenoids or commutator motors.
f. Ambient Temperature, Operating: -13 degrees F to 185 degrees F.

3. Features:
   a. Zero and span trim adjustments using 15-turn potentiometers.
   b. Calibration independent of load.
4. Signal Interface:
   a. Input:
      1) 4 to 20 mA DC.
      2) Impedance: 75 ohms.
   b. Output :
      1) 4 to 20 mA DC.
      2) Drives output load impedance up to 1050 ohms independent of supply voltage to isolator.
5. Enclosure:
   a. NEMA 4X, Type 316 stainless steel, unless otherwise noted.
   b. Mounting: DIN Rail, unless otherwise noted.
6. Power: 115 V AC, unless otherwise noted.
7. Accessories: 3-inch Type T DIN rail strip.
8. Manufacturer:
   a. Acromag Model; 633T Isolators.
   b. Rochester Model; SC-1302 Voltage/Current Transmitter.
   c. AGM; Model PTA 4000.
   d. Or approved equal.

B. Analog Signal Splitter:
1. General:
   a. Function: Split and isolate an analog input current signal into two identical isolated analog output current signals.
   b. Type:
      1) Solid state with external power supply.
      2) Four-way isolation of the input signal, output signals, and external power supply.
   c. Parts: Signal splitter.
2. Performance:
   a. Isolation:
      1) Four-way isolation between input, output 1, output 2, and power circuits for common mode voltages up to 250 V AC, or 354 V DC off ground, on a continuous basis.
      2) Able to withstand 1,500 V AC dielectric strength test for 60 seconds without breakdown.
   b. Output Ripple: Less than ± 0.1 percent of maximum output span.
   c. Accuracy: ± 0.1 percent of output span.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

d. RFI Resistance: IOV/meter at frequencies of 80 to 1,000 MHz AM and 900 MHz keyed carrier, per EN61000-4-3 and ENV50204.
e. EMI resistance: Less than ± 0.25 percent of output span effect under the influence of electromagnetic fields from switching solenoids or commutator motors and drill motors.
f. Ambient Temperature, Operating: -13 degrees F to 167 degrees F.

3. Features:
   a. Two 15-turn potentiometers, Zero and span, per output channel, accessible from front of unit.
   b. Calibration independent of load.
4. Signal Interface:
   a. Input:
      1) 4 to 20 mA DC.
      2) Impedance: 150 ohms at full scale.
   b. Output:
      1) 4 to 20 mA DC each channel.
      2) Drives output load impedance up to 950 ohms.
5. Enclosure:
   a. NEMA 4X, Type 316 stainless steel, unless otherwise noted.
   b. Mounting: DIN Rail, unless otherwise noted.
6. Power: 24V DC, unless otherwise noted.
7. Manufacturer:
   a. Acromag; Model 633T-0100.
   b. Action; IIQ Q404-4.
   c. Phoenix Contact; MCR-FL-C-UI-2UI-DCI.
   d. Or approved equal.

C. LCD Indicator, NEMA 4X:
1. General:
   a. Function: Digital indication of analog signal.
   b. Type:
      1) 4.5-digit LCD display.
      2) NEMA 4X front-panel enclosure.
      3) Loop-powered.
2. Performance:
   a. Operating Temperature Range: -20 degrees C to 65 degrees C.
   b. Accuracy: ± 0.05 percent of span, ± two counts.
3. Type: Front Panel, unless otherwise noted.
4. Features:
   a. Display:
      1) 5-digit LCD.
      2) Panel Front Unit: 0.6-inch high digits.
      3) Loop powered Backlight.
   b. Linearization:
      1) Includes display of square-root extracted signal, applicable for displaying flowrate from a differential producer.
      2) Low flow cutoff in which zero is displayed below a user set point.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

5. Enclosure:
   a. Front Panel Unit:
      1) NEMA 4X/IP65, panel gasket included.
      2) 1/8 DIN, high impact plastic.
      3) Nominal Dimensions: 2.3 inches high by 4.3 inches wide by 6 inches deep.
6. Loop-powered.
7. Signal Interface: 4 to 20 mA at 24 V DC maximum.
8. Manufacturer and Product: Precision Digital, Natick, MA; Model PD 683 (front panel) or approved equal.

2.9 SPARE LIST

A. The PIC supplier shall provide the following:
   1. One (1) luminescent dissolved oxygen analyzer.
   2. One (1) interchangeable analytical transmitter (for use with LDO, suspended solids, and pH).
   3. One (1) submersible pressure transmitter.
   4. One (1) thermal flowmeter.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The instrumentation and accessory equipment shall be installed in accordance with the manufacturer's instructions. The locations of equipment, transmitters, alarms, and similar devices shown on the drawings are approximate only. Exact locations shall be as approved by the Engineer during construction. All information relevant to the placing of process control work shall be obtained in the field. In case of any interference with other work, proceed as directed by the Engineer and furnish all labor and materials necessary to complete the work in an approved manner.

B. The P&ID's indicate the intent of the interconnection between the individual instruments. Any exceptions should be noted.

C. The instrumentation installation details on the Contract Drawings indicate the designed installation for the instruments specified. Where specific installation details are not specified or shown on the Drawings, the American Petroleum Institute (API) Recommended Practice 550 shall be followed as applicable.

D. All work shall be executed in full accordance with codes and local rulings. Should any work be performed contrary to said rulings, ordinances and regulations, the General Contractor shall bear full responsibility for such violations and assume all costs.

E. All equipment used in areas designated as hazardous shall be designed for the Class, Group, and Division as required on the Electrical Drawings for the locations. All work shall be in strict accordance with codes and local rulings. Should any work be performed contrary to said rulings, ordinances, and regulations, the Supplier shall bear full responsibility for such violations and assume all costs.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

F. Unless specifically shown in the Contract Drawings, direct reading or electrical transmitting instrumentation shall not be mounted on process piping. Instrumentation shall be mounted on instrument racks or stands as detailed on the installation detail drawings or an Engineer-approved equal mounting rack or stand. All instrumentation connections shall be provided with shutoff and drain valves.

G. All piping to and from field instrumentation shall be provided with necessary unions, test tees, couplings, adapters, and shut off valves.

H. Brackets and hangers required for equipment mounting shall be provided and shall be installed and not interfere with any other equipment.

I. The shield on each process instrumentation cable shall be continuous from source to destination and be grounded at the source end as directed by the manufacturer of the instrumentation equipment. In no case shall there be more than one ground point for each shield.

3.2 FIELD QUALITY CONTROL

A. Copies of sign off test procedures, forms, and checklists shall constitute the required test documentation.

B. Provide all special testing materials and equipment. Whenever possible, perform tests using actual process variables, equipment, and data. When it is not practical to test with real process variables, equipment, and data, provide suitable means of simulation. Define these simulation techniques in the test procedures.

C. The PIC supplier shall coordinate all testing with the Engineer, all affected Subcontractors, and the Owner.

D. The Engineer’s decision shall be final regarding the acceptability and completeness of all testing.

E. The PIC supplier shall furnish servicemen and all special calibration and test equipment to perform the field tests.

F. The General Contractor shall require the PCSI to maintain the Loop Status Reports and Component Calibration Sheets at the job-site and make them available to the Engineer/Owner at any time.

3.3 TRAINING

A. The Process Instrumentation and Control supplier will include sufficient start-up services and training by factory-trained technicians to allow plant operators to adequately understand the basic principles of operation, application, configuration, and service requirements and techniques for all instrumentation. A start-up and training plan will be submitted to the Owner and Engineer for approval.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

INSTRUMENT TABLE AND MOUNTING DESCRIPTIONS

The "Instrument Table and Mounting Descriptions" forms a part of the Construction Documents and is attached.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

Instrument Table and Mounting Instructions

BIOSOLIDS SYSTEM ADDITION

Tag No.	Spec Section/Para	Instrument Title	Operating Range	P&I D	Mounting Detail
LE/LT 7101, 7102, 7201 & 7202	40 9100 2.4A	Cake hopper ultrasonic level element and transmitters	0 – 10 ft	I7.1.0	Detail No. 8 – I7.8.0; Install per mfg's recommendations
WE 7104 & 7204	44 4617 2.8G	Load cells (6 per hopper)	0 – 120 tons	I7.1.0	Install per mfg's recommendations
MS 7146, 7147, 7161 & 7162	44 4617 2.5I	Live bottom conveyor motion failure switches	NA	I7.1.0	Install per mfg's recommendations
WE 7135 & 7235	44 4256.18 2.7	Cake Hopper load Cell	0 – 1000 lbs	I7.1.0	Install per mfg's recommendations
PE/PT 7135 & 7235	40 9100 2.6B	Cake pump pressure elements	0 – 250 psi	I7.1.0	Detail No. 1 – I7.8.1; Detail No. 6 – I7.8.1; Install per mfg's recommendations
LS 7330	40 9100 2.4B	Pump Pit Float Switch	0 – 5 ft	I7.1.0	Install per mfg's recommendations
PE/PT 7325	40 9100 2.6B	Air Compressor and Receiver	0 – 250 psi	I7.1.0	Detail No. 1 – I7.8.1; Detail No. 6 – I7.8.1; Install per mfg's recommendations
FE/FT 7435	40 9100 2.7A	Scrubber water magnetic flow meter	0 – 500 gpm	I7.1.1	Detail No. 2 – I7.8.2 Install per mfg's recommendations
TE/TT 7436	40 9100 2.5A	Scrubber exit water temperature probe	50 – 150 °F	I7.1.1	Install per mfg's recommendations
TE/TT 7419	40 9100 2.5A	Cooling Conveyor discharge temperature probe	50 – 150 °F	I7.1.1	Install per mfg's recommendations
FE/FIT 7449	40 9100 2.7B	Natural gas flow meter	0 – 15,000 cfh	I7.1.1	Install per mfg's recommendations
PE/PIT 7480	40 9100 2.6D	Natural gas pressure	0 – 3.0 psi	I7.1.1	Detail No. 1 – I7.8.1; Detail No. 6 – I7.8.1; Install per mfg's recommendations

Instrument Table and Mounting Instructions

BIOSOLIDS SYSTEM ADDITION

Tag No.	Spec Section/Para	Instrument Title	Operating Range	P&I D	Mounting Detail
PE/PT 7422	40 9100 2.6B	Transfer blower pressure element	0 – 15 psi	I7.1.2	Detail No. 1 – I7.8.1; Detail No. 6 – I7.8.1; Install per mfg's recommendations
WE 7510 & 7610	41 5616.10 2.5B1	Silo load cells	0 – 125 tons	I7.1.2	Install per mfg's recommendations
TE/TT 7520 & 7620	41 5616.10 2.5B3	Silo temperature probes	0 – 160 °F	I7.1.2	Install per mfg's recommendations
LE/LT 7530 & 7630	41 5616.10 2.5B2	Silo level detector	NA	I7.1.2	Install per mfg's recommendations
AE/AT 7540 & 7640	40 9100 2.3A	Silo carbon monoxide detector	0 – 100 mg/L	I7.1.2	Detail No. 6 – I7.8.0; Install per mfg's recommendations
AE/AT 7550 & 7650	40 9100 2.3A	Oxygen	0 – 21 %	I7.1.2	Detail No. 6 – I7.8.0; Install per mfg's recommendations
PE/PT 7454	43 1400 2.3B & 40 9100 2.6	Nitrogen storage tank pressure element	0 – 150 psi	I7.1.2	Install per mfg's recommendations
LE/LT 7452	43 1400 2.3B & 40 9100 2.4	Nitrogen storage tank level element	0 – 16 ft	I7.1.2	Install per mfg's recommendations
LE/LT 7682	41 5616.10 2.5I & 40 9100 2.4	Mineral oil storage tank level element	0 – 12 ft	I7.1.2	Install per mfg's recommendations
TE/TT 7683	41 5616.10 2.5I & 40 9100 2.5	Mineral oil storage tank temperature element	50 – 140 °F	I7.1.2	Install per mfg's recommendations

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This section gives general requirements for instrumentation and control components.

1.3 SUBMITTALS

A. Furnish submittals in accordance with Division 01, Section “Submittal Procedures”.

B. Product Data:
   1. Include information on all test equipment.
   2. Manufacturer's operation and installation instructions.

C. Shop Drawings:
   1. Complete set of drawings including, but not limited to:
      a. System block diagram showing relationship and connections between devices provided under this Contract. Include manufacturer and model information and address settings.
      b. Network riser diagram.
      c. Network port diagram, which physically locates all, ports within the facility, and identifies their patch panel and switch port.
      d. Construction drawings for all equipment cabinets, including dimensions, identification of all components, preparation and finish data, and nameplates.
      e. Electrical connection diagrams.
      f. Complete grounding requirements.

D. Furnish data sheets for each component together with a technical product brochure or bulletin:
   1. Manufacturer's model number.
   2. Project equipment tag.

E. Complete and detailed bills of materials broken up by each cabinet. Each bill of material item will include the following:
   1. Quantity.
   2. Description.
   3. Manufacturer.
   4. Part numbers.

F. Test Reports:
   1. Signed test results as described in Part 3 of this Section.
   2. Test results shall include:
      a. Narrative describing the test procedures followed.
      b. Block diagram of test set up.
      c. Manufacturer's information on test equipment used.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

d. Detailed test results.
e. A narrative summarizing the results of the testing and identifying any further action required.

G. Operating Manuals:
1. Complete installation, operation, calibration, and testing manuals as described in Division 01, Section "Operation and Maintenance Data".

H. Record Drawings:
1. Electrical connection diagrams shall be revised to reflect any changes made in the field and submitted as record drawings.

1.4 DELIVERY, STORAGE AND HANDLING

A. Protect components against damage according to the manufacturer's recommendations.

1.5 WARRANTIES AND BONDS

A. Provide a warranty against defective or deficient materials and workmanship in accordance with the requirements of Division 01 Section "Closeout Procedures".

B. The equipment manufacturer shall provide a warranty against defective or deficient equipment, workmanship and materials under normal use, operation and service. The warranty shall end a minimum of one year from the date of Substantial Completion. The warranty shall be in printed form and apply to all similar units.

PART 2 - PRODUCTS

2.1 GENERAL

A. Systems Components covers requirements of mechanical components that are not specifically referenced by Division 40, Sections "Instrumentation and Control for Process Systems" or "Package Control Systems".

B. Electrical Components covers requirements for electrical components that are not specifically referenced by Division 40, Sections "Instrumentation and Control for Process Systems" or "Package Control Systems".

C. All other Part 2 articles are also given as a minimum quality requirement for all instruments and components provided by package systems suppliers in addition to the requirements of Division 40, Sections "Instrumentation and Control for Process Systems" and "Package Control Systems".

2.2 SYSTEM COMPONENTS

A. Uninterruptible Power Supply System:
1. General:
a. Function: Provides isolated, regulated uninterrupted AC output power during a complete or partial interruption of incoming line power.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

b. Major Parts: Inverter, battery charger, and sealed battery.

2. Performance:
   a. Capacity: As noted but not less than 1.5 kVA.
   b. Input Power:
      1) 120 Volt AC single phase/60-Hz, unless otherwise noted.
      2) Connections: As noted.
   c. Output Power:
      1) 120 Volt AC single phase/60-Hz, unless otherwise noted.
      2) Connections: As noted.
   d. On-line Efficiency: 85 percent minimum, unless otherwise noted.
   e. Backup Runtime:
      1) Full Load: 9 minutes minimum, unless otherwise noted.
      2) Half Load: 24 minutes minimum, unless otherwise noted.
   f. Continuous, no-break, power with no measurable transfer time.
   g. Sine-Wave Output Power Regulation:
      1) $\pm$ 5 percent or less total harmonic distortion.
      2) Meet or exceed CSA C22.2 No. 107.1 for harmonic distortion.
   h. Voltage Regulation: $\pm$ 3 percent nominal.
   i. Operating Temperature: 0 to 40 degrees C (32 to 104 degrees F).
   j. Lightning and Surge Protection
      1) Pass lightning standard ANS1/IEEE C62.41 Categories A and B test.
      2) 2,000 to I attenuation of input spike.
   k. Isolation:
      1) True separately derived power source as per NEC Article 250-5d with output neutral bonded to ground.
      2) Complete from line.
      3) Less than 2 pF effective input to output capacitance.
3. Features:
   a. Bypass Switches: As noted.
   b. Enclosure: Floor mounted cabinet, unless otherwise noted.
   c. RS232 external interface with full-duplex output capable of:
      1) Remote monitoring of meter functions and alarm conditions.
      2) Remote diagnostic testing.
      3) Remotely set point display and adjustment.
4. Provide a UPS mounted inside the control panel
5. Manufacturers:
   a. Best Power; FERRUPS Uninterruptible Power System.
   b. Liebert; Upstation GXT 24.
   c. Powerware; Model 9120.
   d. Rittal.
   e. Or approved equal.

B. Programmable Control:
1. Programmable Controller: Provide programmable controller with central processor, memory, input/output, interconnecting cables, and optional items as shown on the Drawings and specified:
   a. General Specifications:
      1) Operating Temperature: 0 to 60 degrees C.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2) Humidity: 5 to 95 percent noncondensing.
3) Operating Voltage: 120 volts, 60-Hz (± 10 percent).
4) Maximum Scan Time (Ladder Logic): 3 mS per 1,000 words.
5) Controller Connections: 250 minimum.
6) Network Connections: 100 minimum.

b. Central Processor:
1) Minimum 32-bit microprocessor.
2) User Memory: 2MB, minimum.
3) Provide CPU capable of performing the same functions as a conventional analog and relay logic system including:
a) PID Control.
b) Relays.
c) Timers.
d) Counters.
e) Shift registers.
f) Drum sequencers.
4) Provide CPU capable of data word functions such as:
a) Four-function integer math.
b) Data shift registers.
c) Data word move.
d) Data file compare with pointer.
e) File move.
5) Programming Languages:
a) Relay Ladder.
b) Function Block.
6) Provide CPU capable of monitoring the following system failures and alarm operator and shutdown if a failure occurs.
a) Memory failure.
b) User program longitudinal redundancy error.
c) Memory battery low, if applicable.
d) Input/output subsystem error.
e) Watchdog timer time out.
7) Memory:
a) Type: Random Access Memory (RAM).
b) The programmable control memory shall consist of the following functional types of memory:
- Ladder logic program memory.
- Analog processor memory.
- Variable data memory.
- Input/output data memory.
- Miscellaneous.

c) Provide nonvolatile user memory to backup PLC program.
8) PLC Communication Ports: As a minimum, provide the following communication ports for each PLC:
a) One port for connection to laptop programmer.
b) One port for Ethernet communication with Owner's SCADA System.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

c) One port for Ethernet communication with panel mounted industrial, environmentally hardened, operator interface.

9) Provide two copies of professional version PLC programming software and two copies of Professional version PLC communication software and drivers for the PLC.

10) Provide software as required for proper operation of HMIs.

2. PLC I/O Subsystem:
   a. Input/Output: Provide all hardware necessary for the CPU to communicate with the specified types of input and output modules. Provide remote I/O rack configuration where shown or specified.
   b. Each I/O block shall be individually fused.
   c. Discrete Input Modules:
      1) Type: 120-volt, 60-Hz or 24 V DC; surge protected by devices conforming to the requirements of IEEE Standard 28 (ANSI C62.1).
      2) TTL compatible imposed on the input module.
      3) Inputs per module: 8 minimum and 32 maximum.
      4) Noise filters: Reject short-time constant noise and 60-Hz pickup. Individual input point shall be capable of withstanding low energy common mode transients to 1,500 volts without catastrophic failure.
      5) Status lights for each input and barrier type terminal blocks for termination of the field wires. Provide module constructed such that the field wires do not have to be removed while replacing the module.
   d. Discrete Outputs:
      1) Type: 24 V DC triac outputs suitable for driving relays, solenoid operated valves.
      2) Outputs per module: 8 minimum and 32 maximum.
      3) Provide output modules that are protected from damage by inductively generated, NORMAL mode, and LOW energy common mode transients to 1,500 volts peak.
      4) Provide discrete outputs that fail open when a PLC failure is detected.
      5) Provide isolated interposing relays for all discrete outputs.
      6) Status lights for each output point and barrier type terminal blocks for termination of the output wires. Provide module constructed such that the field wires do not have to be removed while replacing the module.
   e. Analog Inputs:
      1) Type: Nonisolated, Single Ended, accepts a 4 to 20 mA DC signal.
      2) Accuracy: $\pm$ 5 percent of full scale.
      3) Provide input module capable of withstanding low common mode transients of 1,500 volts peak without catastrophic PLC failure.
   f. Analog Outputs:
      1) Type: Nonisolated, Single Ended, outputs a 4 to 20 mA signal suitable for driving a 0 to 600 ohm load.
      2) Accuracy: $\pm$ 5 percent of full scale.
3. Provide the following chassis-mounted communication modules as indicated on drawings:
   a. Ethernet Communications interface module.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

4. Provide each I/O chassis with power supply, Ethernet module, required I/O modules, and required backplane connectors for additional chassis as required to accommodate I/O for a given panel compatible with the PLC.
5. The PLC system shall be as manufactured by the following manufacturers with compatible I/O modules and racks:
    a. Allen-Bradley; Control Logix L62 Processor with eWeb Ethernet module.
    b. Or approved equal
6. Industrial, Environmentally Hardened Operator Interface:
    a. General:
        1) Contractor shall provide the latest hardware available during the submittal process, and shall upgrade features as necessary. The following specifications outline minimum requirements for each interface.
        2) General: Operator access to PLC control and monitoring applications.
        3) Type: Color display and touchscreen.
    b. Touchscreen Features:
        1) Type: Analog Resistive.
    c. Display Features:
        1) Description: Color active matrix thin film transistor (TFT).
        2) Size: 10.4 inches.
        3) Area: 8.3 inches by 6.2 inches.
        4) Resolution: 640 by 480, 18-bit color graphics.
        5) Backlight: 50,000 hours, field replaceable.
        6) Real-Time Clock: Battery-backed time clock timestamps critical data.
        7) Mounting: Panel Mount. Provide mounting hardware as required to mount to panel.
    d. Application Memory:
        1) RAM: 128 MB.
        2) Flash: 128 MB.
        3) Application Storage: 115 MB.
    e. Application Software: Compatible with the PLC hardware selection.
    f. Input Voltage: 85 to 264 V AC, 47 to 63 Hz.
    g. Communication Ports: Ethernet.
    h. Environmental:
        1) Operating Temperature: 32 to 131 degrees F.
        2) Relative Humidity: 5-95 percent, noncondensing.
        3) Shock: 15 gat 11 Ims.
        4) Rating: NEMA 4X, IP65.
    i. Manufacturer and Product:
        1) Allen-Bradley; Versaview CE 150H
        2) Or approved equal compatible with the PLC hardware and software selected.

C. Remote I/O:
1. General: All basic requirements are similar to programmable logic controller, unless noted herein.
2. Provide remote I/O to meet requirements of the Loop Specifications and Block Diagram

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3. Provide PLC manufacturer standard remote I/O compatible with programmable logic controller.
4. A CPU is not required for remote I/O.
5. Provide remote I/O of same manufacturer as programmable logic controller. The remote I/O data link shall be of same manufacturer as programmable logic controller.
6. Hardware Components:
    a. Power Supply: Required.
    b. Chassis: Chassis may be integral or separate.
    c. Discrete Input Modules: Of same manufacturer as programmable logic controller.
    d. Discrete Output Modules: Of same manufacturer as programmable logic controller.
    e. Analog input modules: Of same manufacturer as programmable logic controller.
    f. Analog Output Modules: Of same manufacturer as programmable logic controller.
    g. Ethernet Modules: Of same manufacturer as programmable logic controller.

2.3 SPARE LIST

A. The PIC supplier shall provide the following spares:
1. One (1) PLC CPU.
2. One (1) each type module (A1, AO, D1, D0).
3. One (1) PLC power supply.
4. One (1) PLC ethernet module.
5. One (1) intrinsic safety barrier.
6. Five (5) fused terminal blocks.
7. Five (5) each type relay and base.
8. Five (5) each type of panel fuse.
9. Two (2) analog surge suppressions (field).

PART 3 - EXECUTION

3.1 INSTALLATION

A. The process control system shall be installed in accordance with the manufacturer's instructions. The locations of equipment are approximate only. Exact locations shall be as approved by the Engineer during construction. All information relevant to the placing of process control work shall be obtained in the field. In case of any interference with other work, proceed as directed by the Engineer and furnish all labor and materials necessary to complete the work in an approved manner.

B. The P&ID’s indicate the intent of the interconnection between the individual control components. Any exceptions should be noted.

C. Following completion of installation and the start-up testing, one set of the marked up drawings shall be provided to the Engineer; the other set shall be retained by the Supplier for incorporation of the mark-ups into final as-built documentation.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

D. All work shall be executed in full accordance with codes and local rulings. Should any work be performed contrary to said rulings, ordinances and regulations, the General Contractor shall bear full responsibility for such violations and assume all costs.

E. All equipment used in areas designated as hazardous shall be designed for the Class, Group, and Division as required on the Electrical Drawings for the locations. All work shall be in strict accordance with codes and local rulings. Should any work be performed contrary to said rulings, ordinances and regulations, the Supplier shall bear full responsibility for such violations and assume all costs.

F. The PIC supplier, acting through the General Contractor, shall coordinate the installation, the placing, and location of system components, and their connections to the process equipment panels, cabinets, and devices, subject to the Engineer's approval.

3.2 FIELD QUALITY CONTROL

A. The PIC supplier shall test all equipment at the factory prior to shipment.

B. As a minimum, the testing shall include the following:
   1. Factory Testing: Prior to shipment of the equipment, the following tests are required:
      a. Unwitnessed Factory Test (UFT)
   2. Field Testing: Following installation of the process control system components and prior to plant startup the following tests are required:
      a. Operational Readiness Test (ORT)
      b. Functional Demonstration Test (FDT)
   3. Each test shall be in the cause and effect format. The person conducting the test shall initiate an input (cause) and, upon the system's or subsystem's producing the correct result (effect), the specific test requirement shall be satisfied.
   4. Copies of sign off test procedures, forms, and checklists shall constitute the required test documentation.
   5. Provide all special testing materials and equipment. Provide suitable means of simulation.
   6. The PIC supplier shall coordinate all testing with the Engineer, all affected Subcontractors, and the Owner.
   7. The Engineer’s decision shall be final regarding the acceptability and completeness of all testing.
   8. No equipment shall be shipped until the Engineer has received all test results and approved the system.
   9. The PIC supplier shall furnish service personnel and all special calibration and test equipment to perform the field tests.

3.3 UNWITNESSED FACTORY TEST (UFT).

A. The entire system except for primary elements, final control elements, and field mounted transmitters, shall be interconnected and tested to ensure the system will operate as specified. All analog and discrete input/output points not interconnected at this time shall be simulated to ensure proper operation of all alarms, monitoring devices/functions, and control devices/functions.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. All panels, consoles, and assemblies shall be inspected and tested to verify that they are in conformance with related submittals, Specifications and Drawings. During the tests, all digital system hardware and software shall be operated for at least five days continuously without a failure to verify that the system is capable of continuous operation.

C. Submit UFT results for review by the Engineer

3.4 FACTORY DEMOSTRATION TEST (FDT)

A. Prior to startup and the functional demonstration test, the entire system shall be certified (inspected, tested, and documented) that it is ready for operation.

B. Loop/Component Inspections and Tests: The entire system shall be checked for proper installation, calibrated, and adjusted on a loop-by-loop and component-by-component basis to ensure that it is in conformance with related submittals and these Specifications.
   1. Each loop shall have a Loop Status Report to organize and track its inspection, adjustment, and calibration.
   2. Each active Analog Subsystem element and each I/O module shall have a Component Calibration Sheet.
   3. The Engineer shall review and initial all Loop Status Sheets and Component Calibration Sheets and spot-check their entries periodically and upon completion of the testing.
   4. PIC supplier shall notify Engineer and Owner of testing during this phase, who may choose to be present at their own expense.

3.5 FUNCTIONAL TEST

A. Prior to startup, the entire installed instrument and control system shall be certified that it is ready for operation. All preliminary testing, inspection, and calibration shall be complete as defined in the FDT.

B. Once the facility has been started up and is operating, a witnessed FDT shall be performed on the complete system to demonstrate that it is operating and in compliance with these specifications.

C. Updated versions of the documentation shall be made available to the Engineer at the job-site both before and during the tests. In addition, one copy of all O&M Manuals shall be made available to the Engineer at the job site both before and during testing.

D. The system shall operate for five (5) consecutive days without major failure before this test shall be considered successful. System failure determination to be at the discretion of the Engineer.

3.6 TRAINING

A. As specified in Division 40 Section "Instrumentation and Control for Process Piping".

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3.7 SUPPLEMENT

A. The supplement listed below follows "End of Section" and is part of this Specification.
   1. Control Panel Schedule.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

CONTROL PANEL SCHEDULE AND NETWORK COMMUNICATIONS CABINETS

The "Control Panel Schedule and Network Communications Cabinets" forms a part of the Construction Documents and is attached.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

Control Panel Schedule and Network Communication Cabinets

CONTROL PANEL SCHEDULE

Panel Name & No.	PLC No.	PLC Mfr & Model	Plant Area	Location	Controls	P&ID No.	Comments/Notes
Wet Cake Hopper Panel (BSCHCP-7010)	NA	Allen Bradley ControlLogix	7	Biosolids Building	Wet Cake Hoppers BSCH-7110 & BSCH-7210	I7.1.0	NEMA 4X
Wet Cake Feed Pump Panel (BSPCP-7020)	NA	Allen Bradley ControlLogix	7	Biosolids Building	Wet Cake Feed Pumps BSP-7130 & BSP-7230	I7.1.0	NEMA 4X
Biosolids Dryer Control Panel (BSDCP-7030)	NA	Allen Bradley ControlLogix	7	Biosolids Building	Indirect Dryer BSD-7400	I7.1.1	NEMA 4X
Biosolids Pneumatic Transfer System	NA	NA	7	Biosolids Building	Transfer Blowers BSTB-7420 & BSTB-7421 and Rotary Valve (or Pneumatic Eductor) BSTB-7416	I7.1.2	MCC-4
Biosolids Silos Panel (BSSCP-7040)	NA	Allen Bradley ControlLogix	7	Outside of Biosolids Building	Biosolid Storage Silos BSS-7500 & BSS-7600	I7.1.2	NEMA 4X

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes requirements for:
   1. Materials and equipment used in process control and LAN networks, including:
      a. Network hubs.
      b. Network switches.
      c. Media converters.
      d. Routers.
      e. Patch panels and other data network hardware.
      f. Panel components
      g. Related accessories.

B. Related Sections: The Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the CONTRACTOR and its Subcontractors to review all sections to ensure a complete and coordinated project.

C. Provide all network equipment identified in the Contract Documents.

1.3 REFERENCES

A. TIA/EIA Standards:
   1. TIA/EIA-568-B (Series), "Commercial Building Telecommunications Standards".
   2. TIA/EIA-569 (Series), "Commercial Building Standard for Telecommunications Pathways and Spaces".
   3. IEEE Series 802 standards.

1.4 SUBMITTALS

A. Furnish submittals in accordance with Division 01, Section “Submittal Procedures”.

B. Product Data:
   1. Include information on all test equipment.
   2. Manufacturer's operation and installation instructions.

C. Shop Drawings:
   1. Complete set of drawings including, but not limited to:
      a. System block diagram showing relationship and connections between devices provided under this Contract. Include manufacturer and model information and address settings.
      b. Network riser diagram.
      c. Network port diagram, which physically locates all ports within the facility and identifies their patch panel and switch port.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

d. Construction drawings for all equipment cabinets, including dimensions, identification of all components, preparation and finish data, and nameplates.
e. Electrical connection diagrams.
f. Complete grounding requirements.

D. Furnish data sheets for each component together with a technical product brochure or bulletin:
1. Manufacturer's model number.
2. Project equipment tag.

E. Complete and detailed bills of materials broken up by each cabinet. Each bill of material item will include the following:
1. Quantity.
2. Description.
3. Manufacturer.
4. Part numbers.

F. Test Reports:
1. Signed test results as described in Part 3 of this Section.
2. Test results shall include:
a. Narrative describing the test procedures followed.
b. Block diagram of test set-up.
c. Manufacturer's information on test equipment used.
d. Detailed test results.
e. A narrative summarizing the results of the testing and identifying any further action required.

G. Operating Manuals:
1. Complete installation, operation, calibration, and testing manuals as described in Division 01, Section “Operation and Maintenance Data”.

H. Record Drawings:
1. Electrical connection diagrams shall be revised to reflect any changes made in the field and submitted as record drawings.

1.5 DELIVERY, STORAGE AND HANDLING

A. Protect components against damage according to the manufacturer’s recommendations.

1.6 WARRANTIES AND BONDS

A. Provide a warranty against defective or deficient materials and workmanship in accordance with the requirements of Division 01 Section “Closeout Procedures”.

B. The equipment manufacturer shall provide a warranty against defective or deficient equipment, workmanship and materials under normal use, operation and service. The warranty shall end a minimum of one year from the date of Substantial Completion. The warranty shall be in printed form and apply to all similar units.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1.7 MAINTENANCE

A. Spare parts:
   1. Provide 3 spare fuses for each size and type used or supplied under any Division of these Specifications.

PART 2 - PRODUCTS

2.1 PROCESS CONTROL PANEL HARDWARE

A. Terminal Blocks for Enclosures:
   1. General:
      a. Connection Type: Screw compression clamp.
      b. Compression Clamp:
         1) Complies with DIN-VDE 0611.
         2) Hardened steel clamp with transversal grooves that penetrate wire strands providing a vibration-proof connection.
         3) Guides strands of wire into terminal.
      c. Screws: Hardened steel, captive, and self-locking.
      d. Current Bar: Copper or treated brass.
      e. Insulation:
         1) Thermoplastic rated for -55 degrees C to 110 degrees C.
         2) Two funneled shaped inputs to facilitate wire entry.
      f. Mounting:
         1) Standard DIN rail.
         2) Terminal block can be extracted from an assembly without displacing adjacent blocks.
         3) End Stops: Minimum of one at each end of rail.
      g. Wire Preparation: Stripping only permitted.
      h. Jumpers: Allow jumper installation without loss of space on terminal or rail.
      i. Marking System:
         1) Terminal number shown on both sides of terminal block.
         2) Allow use of preprinted and field marked tags.
         3) Terminal strip numbers shown on end stops.
         4) Mark terminal block and terminal strip numbers as shown on panel control diagrams and loop diagrams.
         5) Fuse Marking for Fused Terminal Blocks: Fuse voltage and amperage rating shown on top of terminal block.
      j. Test Plugs: Soldered connections for 18 AWG wire.
         1) Pin Diameter: 0.079 inch.
         2) Manufacturer and Product:
            a) Entrelec; Type FC2.
            b) Weidmuller.
            c) Allen-Bradley.
            d) Or approved equal.
   2. Terminal Block, General Purpose:
      a. Rated Voltage: 600V AC.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

b. Rated Current: 30 amps.
c. Wire Size: 24 AWG to 10 AWG.
d. Rated Wire Size: 10 AWG.
e. Color: Gray body.
f. Spacing: 0.25 inch, maximum.
g. Test Sockets: One screw test socket 0.079-inch diameter.
h. Manufacturer and Product:
    1) Entrelec; Type M4/6.T.
    2) Weidmuller.
    3) Allen-Bradley.
    4) Or approved equal.

3. Terminal Block, Ground:
    a. Wire Size: 24 AWG to 10 AWG.
    b. Rated Wire Size: 10 AWG.
    c. Color: Green and yellow body.
    d. Spacing: 0.25 inch, maximum.
    e. Grounding: Electrically grounded to mounting rail.
    f. Manufacturer and Product:
        1) Entrelec; Type M4/6.P.
        2) Weidmuller.
        3) Allen-Bradley.
        4) Or approved equal.
4. Terminal Block, Blade Disconnect Switch:
    a. Rated Voltage: 600V AC.
    b. Rated Current: 10 amps.
    c. Wire Size: 22 AWG to 10 AWG.
    d. Rated Wire Size: 10 AWG.
    e. Color: Gray body, orange switch.
    f. Spacing: 0.25 inch, maximum.
    g. Manufacturer and Product:
        1) Entrelec; Type M4/6.SNT.
        2) Weidmuller.
        3) Allen-Bradley.
        4) Or approved equal.
5. Terminal Block Diode:
    a. Rated Voltage: 24V DC.
    b. Rated Current: 30 mA.
    c. Wire Size: 16 AWG.
    d. Manufacturer and Product: Phoenix Contact ST-IN or approved equal.
6. Terminal Block, Fused, 24V DC (provide for each discrete input):
    a. Rated Voltage: 600V DC.
    b. Rated Current: 25 amps.
    c. Wire Size: 22 AWG to 10 AWG.
    d. Rated Wire Size: 10 AWG.
    e. Color: Gray body.
    f. Fuse: 0.25 inch by 1.25 inches.
    g. Indication: LED diode 24V DC.
    h. Spacing: 0.512 inch, maximum.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

i. Manufacturer and Product:
   1) Entrelec; Type ML1O/13.SFD.
   2) Weidmuller.
   3) Allen-Bradley
   4) Or approved equal.

7. Terminal Block, Fused, 120V AC:
   a. Rated Voltage: 600V AC.
   b. Rated Current: 25 amps.
   c. Wire Size: 22 AWG to 10 AWG.
   d. Rated Wire Size: 10 AWG.
   e. Color: Gray body.
   f. Fuse: 0.25 inch by 1.25 inches.
   g. Indication: Neon lamp, 110V AC.
   h. Leakage Current: 1.8 mA, maximum.
   i. Spacing: 0.512 inch, maximum.
   j. Manufacturer and Product:
      1) Entrelec; Type MLIO/13.SFL.
      2) Weidmuller.
      3) Allen-Bradley.
      4) Or approved equal.
8. Terminal Block, Fused, 120V AC, High Current:
   a. Rated Voltage: 600V AC.
   b. Rated Current: 35 amps.
   c. Wire Size: 18 AWG to 8 AWG.
   d. Rated Wire Size: 8 AWG.
   e. Color: Gray.
   f. Fuse: 13/32 inch by 1.5 inches.
   g. Spacing: 0.95 inch, maximum.
9. Manufacturer and Product:
   a. Entrelec; Type MB10/24.SF.
   b. Weidmuller.
   c. Allen-Bradley.
   d. Or approved equal.

B. Relays:
1. General:
   a. Relay Mounting: Plug-in type socket.
   b. Relay Enclosure: Furnish dust cover.
   c. Socket Type: Screw terminal interface with wiring.
   d. Socket Mounting: Rail.
   e. Provide holddown clips.
2. Signal Switching Relay (provide for each discrete input):
   a. Type: Dry circuit.
   b. Contact Arrangement: 2 Form C contacts.
   c. Contact Rating: 5 amps at 28V DC or 120V AC.
   d. Contact Material: Gold or silver.
   e. Coil Voltage: As noted or shown.
   f. Coil Power: 0.9 watt (DC), 1.2VA (AC).
   g. Expected Mechanical Life: 10,000,000 operations.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

h. Expected Electrical Life at Rated Load: 100,000 operations.
i. Indication Type: Neon or LED indicator lamp.
j. Seal Type: Hermetically sealed case.
k. Manufacturer and Product:
   1) Potter and Brumfield; Series KH/KHA.
   2) Idec.
   3) Allen-Bradley.
   4) Or approved equal.

3. Control Circuit Switching Relay, Nonlatching (provide for each discrete output):
   a. Type: Compact general purpose plug-in.
   b. Contact Arrangement: 3 Form C contacts.
   c. Contact Rating: 10A at 28V DC or 120V AC, and 6.6A at 240V AC.
   d. Contact Material: Silver cadmium oxide alloy.
   e. Coil Voltage: As noted or shown.
   f. Coil Power: 1.8 watts (DC), 2.7VA (AC).
   g. Expected Mechanical Life: 10,000,000 operations.
   h. Expected Electrical Life at Rated Load: 100,000 operations.
   i. Indication Type: Neon or LED indicator lamp.
   j. Push-to-test button.
   k. Manufacturer and Product:
      1) Potter and Brumfield; Series KUP.
      2) Idec.
      3) Allen-Bradley.
      4) Or approved equal.
4. Control Circuit Switching Relay, Latching:
   a. Type: Dual coil mechanical latching relay.
   b. Contact Arrangement: 2 Form C contacts.
   c. Contact Rating: 10A at 28V DC or 120V AC.
   d. Contact Material: Silver cadmium oxide alloy.
   e. Coil Voltage: As noted or shown.
   f. Coil Power: 2.7 watts (DC), 5.3VA (AC).
   g. Expected Mechanical Life: 500,000 operations.
   h. Expected Electrical Life at Rated Load: 50,000 operations.
   i. Manufacturer and Product:
      1) Potter and Brumfield; Series KB/KBP.
      2) Idec.
      3) Allen-Bradley.
      4) Or approved equal.
5. Control Circuit Switching Relay, Time Delay:
   a. Type: Adjustable time delay relay.
   b. Contact Arrangement: 2 Form C contacts.
   c. Contact Rating: 10A at 30V DC or 277V AC.
   d. Contact Material: Silver cadmium oxide alloy.
   e. Coil Voltage: As noted or shown.
   f. Operating Temperature: -10 degrees C to 55 degrees C.
   g. Repeatability: $\pm$ 2 percent.
   h. Delay Time Range: Select range such that time delay set point fall between 20 percent to 80 percent of range.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

i. Time Delay Set Point: As noted or shown.
j. Mode of Operation: As noted or shown.
k. Adjustment Type: Integral potentiometer with knob external to dust cover.
l. Manufacturer and Products:
1) Potter and Brumfield; Series CB for 0.1-second to 100-minute delay time ranges, Series CK for 0.1-second to 120-second delay time ranges.
2) Idec.
3) Tyco/Agastat.
4) Or approved equal.

C. Surge Suppressors:
1. General:
a. Construction: First-stage high-energy metal oxide varistor and second-stage bipolar silicon avalanche device separated by series impedance; includes grounding wire, stud, or terminal.
b. Response: 5 nanoseconds maximum.
c. Recovery: Automatic.
d. Temperature Range: -20 degrees C to 85 degrees C.
2. Suppressors on 120V AC Power Supply Connections:
a. Occurrences: Tested and rated for a minimum of 50 occurrences of IEEE C62.41 Category B test waveform.
b. First-Stage Clamping Voltage: 350 volts or less.
c. Second-Stage Clamping Voltage: 210 volts or less.
d. Continuous Operation: Power supplies for one four-wire transmitter or receiver: 5 amps minimum at 130V AC. All other applications: 30 amps minimum at 130V AC.
3. Suppressors on Analog Signal Lines:
a. Test Waveform: Linear 8 microsecond rise in current from 0 amps to a peak current value followed by an exponential decay of current reaching one-half the peak value in 20 microseconds.
b. Surge Rating: Tested and rated for 50 occurrences of 2,000-amp peak test waveform.
1) DC Clamping Voltage: 20 percent to 40 percent above operating voltage for circuit.
2) DC Clamping Voltage Tolerance: Less than $\pm$ 10 percent.
3) Maximum Loop Resistance: 18 ohms per conductor.
4. Physical Characteristics:
a. Mounted in Enclosures: Encapsulated inflame retardant epoxy.
b. For Analog Signals Lines, Type SS2: EDCO PC-642 series.
c. For 120V AC Lines, Type SSI: EDCO HSP-121.
d. Field Mounted at Two-Wire Instruments: Encapsulated in stainless steel pipe nipples, Type SS3. EDCO SS64 series.
e. Field Mounted at Four-Wire Instruments: With 120V AC outlet, AC circuit breaker, and 10-ohm resistors on signal lines, all in enclosure, Type SS4.
1) Enclosure:
a) NEMA 4X.
b) Maximum Size: 12 inches by 12 inches by 8 inches deep.
2) Manufacturer and Product: EDCO; SLAC series, or approved equal.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

D. Power Supplies:
   1. Furnish as required to power instruments requiring external DC power, including two-wire transmitters and DC relays. Provide dual power supplies with internal diode auctioneered outputs.
   2. Provide industrial rated UL 508 listed power supply.
   3. Convert 120V AC, 60-Hz power to DC power of appropriate voltage(s) with sufficient voltage regulation and ripple control to assure that instruments being supplied can operate within their required tolerances.
   4. Provide output over voltage and over current protective devices to:
      a. Protect instruments from damage due to power supply failure.
      b. Protect power supply from damage due to external failure.
   5. Enclosures: NEMA 1/IP20.
   6. Mount such that dissipated heat does not adversely affect other components.
   7. Fuses: For each DC supply line to each individual two-wire transmitter.
      a. Type: Indicating.
      b. Mount so fuses can be easily seen and replaced.
   8. Manufacturers:
      a. Idec.
      b. Allen-Bradley.
      c. Phoenix Contact.
      d. Or approved equal.

E. Intrinsically Safe Components:
   1. Provide as shown on Drawings and as required by NFPA 70 (National Electric Code) for hazardous locations as designated by the Engineer and NFPA 820.
   2. Install in accordance with the National Electric Code.
   3. Provide UL listed Intrinsically Safe Relays and Intrinsically Safe Barriers selected based on the entity parameters of the associated instrument or device.
   4. Intrinsically Safe Relays: Monitor discrete signals that originate in hazardous area and are used in a safe area.
      a. Manufacturers:
         1) MTL, Inc.
         2) Stahl.
         3) Or approved equal.
   5. Intrinsically Safe Barriers: Interface analog signals as they pass from hazardous area to safe area.
      a. Manufacturers:
         1) MTL, Inc.
         2) Stahl (Part No. 9002/13-280-100-041).
         3) Or approved equal.

F. Front-of-Panel Devices in Conjunction with NEMA 250, Type 1 and 12 Panels:
   1. Potentiometer Units:
      a. Three-terminal, oiltight construction, resolution of 1 percent and linearity of $\pm$ 5 percent.
      b. Single-hole, panel mounting accommodating panel thicknesses between 1/8 and 1/4 inch.
      c. Include legend plates with service markings.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

d. Manufacturers and Products:
   1) Allen-Bradley; Model 800T.
   2) Or approved equal.

2. Indicating Lights:
   a. Heavy-duty, push-to-test type, oiltight, industrial type with integral transformer for 120V AC applications.
   b. Screwed on prismatic glass lenses in colors noted and factory engraved legend plates for service legend.
   c. Manufacturers and Products:
      1) Eaton/Cutler-Hammer; Type 10250T.
      2) Or approved equal.
3. Pushbutton, Momentary:
   a. Heavy-duty, oiltight, industrial type with full guard and momentary contacts rated for 10 amperes continuous at 120V AC.
   b. Standard size legend plates with black field and white markings for service legend.
   c. Manufacturers and Products:
      1) Square D; Class 9001, Type K.
      2) Eaton/Cutler-Hammer; Type T.
      3) Or approved equal.
4. Selector Switch:
   a. Heavy-duty, oiltight, industrial type with contacts rated for 120V AC service at 10 amperes continuous.
   b. Standard size, black field, legend plates with white markings, for service legend.
   c. Operators: Black knob type.
   d. Single-hole mounting, accommodating panel thicknesses from 1/16 inch to 1/4 inch.
   e. Manufacturers and Products for Units with up to Four Selection Positions:
      1) Eaton/Cutler-Hammer; Type T.
      2) Or approved equal.
   f. Manufacturers and Products for Units with up to 12 Selection Positions:
      1) Rundel-Idec; Standard Cam Switch.
      2) Electroswitch; 31.
      3) Or approved equal.

G. Front-of-Panel Devices Used in Conjunction with NEMA 250, Type 4X Panels:
1. Potentiometer, Watertight:
   a. Three-terminal, heavy-duty NEMA 250, Type 4X watertight construction, resolution of 1 percent and linearity of $\pm$ 5 percent.
   b. Single-hole, panel mounting accommodating panel thicknesses between 1/8 and 1/4 inch.
   c. Include engraved legend plates with service markings.
   d. Manufacturer and Product: Allen-Bradley; Bulletin 800H or approved equal.
2. Indicating Lights, Watertight:
   a. Heavy-duty, push-to-test type, NEMA 250, Type 4X watertight, industrial type with integral transformer for 120V AC applications and corrosion-resistant service.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

b. Screwed on prismatic lenses and factory engraved legend plates for service legend.
c. Manufacturers and Products:
1) Square D; Type SK.
2) Allen-Bradley; Type 800H.
3) Or approved equal.

3. Pushbutton, Momentary, Watertight:
a. Heavy-duty, NEMA 250, Type 4X watertight, industrial type with momentary contacts rated for 120V AC service at 10 amperes continuous and corrosion-resistant service.
b. Standard size, black field, legend plates with white markings for service legend.
c. Manufacturers and Products:
1) Square D; Type SK.
2) Allen-Bradley; Type 800H.
3) Or approved equal.

4. Selector Switch, Watertight:
a. Heavy-duty, NEMA 250, Type 4X watertight, industrial type with contacts rated for 120V AC service at 10 amperes continuous and corrosion-resistant service.
b. Standard size, black field, legend plates with white markings, for service legend.
c. Operators: Black knob type.
d. Single-hole mounting, accommodating panel thicknesses from 1/16 to 1/4 inch.
e. Manufacturer and Products:
1) Square D; Class 9001, Type SK.
2) Allen-Bradley; Type 800H.
3) Or approved equal.

2.2 PROCESS CONTROL NETWORK HARDWARE

A. Ethernet Switches:
1. Enterprise Ethernet Switches:
a. Manufacturers - One of the following in the Administration Building:
1) Moxa PT7324 Series.
2) Or Approved Equal.
b. Hardware Properties:
1) 19-inch rack mountable.
2) Power supply:
a) Universal high voltage range: 125/250 VDC (88 to 300 V) and 110/240 VAC (85 to 264 V)
b) Low voltage ranges: 24 VDC (18-36 VDC), 48 VDC (36-72 VDC) console management port.
3) 22 10/100/1000 Ethernet Ports.
4) 2 Fiber Uplink Ports.
c. Network and Software Interface Standards
1) EEE802.3 for 10BaseT.
2) EEE802.3u for 100BaseTX and 100Base FX.
3) EEE802.3ab for 1000BaseTX.
4) EEE802.3z for 1000BaseSX/LX/CX.
5) EEE 802.3x for Flow Control.
6) EEE802.1p for Class of Service.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

d. Environment:
   1) Operating Temperature Range: -40 to 85 degrees C.
   2) Humidity: 15 to 95 percent, non-condensing.

e. Web Console Page Accessible Functionality
   1) Configuring basic settings includes settings of system identification, password, port, network, local import/export, restart, and factory default.
   2) Configuring bandwidth management.
   3) Configuring traffic prioritization.
   4) Configuring virtual LAN.
   5) Configuring relay warning.
   6) Configuring monitor.

2. Managed Industrial Ethernet Switches:
   a. Manufacturers - Five of the following in the various plant areas:
      1) Moxa EDS-G509 Series.
      2) Or Approved Equal.
   b. Hardware Properties:
      1) DIN rail mountable.
      2) Power supply: Redundant 12/24/48 VDC, 24 VDC nominal.
      3) Minimum 4 10/100/1000 BaseT(X) ports.
      4) 2 Fiber Uplink Ports.
   c. Environment:
      1) Operating Temperature Range: -40 to 75 degrees C.
      2) Humidity: 15 to 95 percent, non-condensing.
   d. Communications Redundancy
      1) The switch can detect and, without manual intervention, provide an alternate path in the event of a loss of communications. The switch can detect and compensate for the failure of another switch, cable disruption, or hardware failure of one or more ports.
      2) IEEE standards based redundancy, including IEEE 802.1D/w spanning tree.
      3) Turbo ring.
      4) Fast Ethernet Redundant Ring Capability (Recovery Time < 20 ms).
      5) Ring coupling function to integrate different Turbo Ring for distributed application.
   e. Web Console Page Accessible Functionality
      1) Configuring Basic Settings includes settings of System Identification, Password, Accessible IP, Port, Network, Time server, TFTP Server and Import/Export.
      2) Configuring Port Trunking.
      3) Configuring SNMP V1/V2c/V3.
      4) Configuring Communication Redundancies of IEEE802.1D/w and Turbo Ring.
      5) Configuring Traffic Prioritization.
      6) Configuring Virtual LAN.
      7) Configuring Multicast Filtering.
      8) Configuring Bandwidth Management.
      9) Configuring Port Access Control.
      10) Configuring Auto Warning of e-mail and relay warning.
      11) Configuring Line-Swap-Fast-Recovery.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

12) Configuring Set Device IP.
13) Configuring Diagnosis.
14) Configuring Port Monitor.
15) Configuring DHCP Option 82.
16) Display the MAC Address Table.
17) Display Event Log.

B. Routers:
1. Manufacturers - One of the following:
   a. Cisco 2800.
   b. Approved Equal.
2. Properties:
   a. USB Port.
   b. Compact Flash Port.
   c. 128 MB RAM.
   d. Hardware: 19 inch rack mountable.
   e. Power supply, redundant, 120 VAC, 60 Hertz, 1-phase, 280 watts.
   f. Two Ethernet ports 10/100 TX.
3. Environment:
   a. Operating Temperature Range: -40 to 85 degrees Fahrenheit.
   b. Humidity: 15 to 70 percent, non-condensing.
4. Capable of performing basic filtering and networking with web based graphical user interface:
   a. VPN Support.
   b. IP Phone Support.
   c. Email Support for 100 mailboxes.
5. Interface Card Slots:
   a. 2 slots support for HWIC, WIC, VIC, and VWIC.
   b. 1 slot support for WIC, VIC, and VWIC.
   c. 1 slot support for VIC and VWIC.
6. Mounting:
   a. Provide hardware for 19 inch rack mounting hardware.

C. Patch panels:
1. All optical fibers shall be provided with strain relief and terminated at a fiber patch panel. All patch panel terminations shall be SC type. Final connections between the patch panel and the fiber optic network equipment shall be made via fiber optic patch cords.
2. All fibers, active and dark, shall be terminated at the patch panels.
3. Interconnect and patch panel housings shall provide space for excess fiber and provide strain relief for the fiber cable.
4. Fiber cables shall be installed such that the outer sheath of the cable is carried into the interconnect enclosure or patch panels before breaking out buffer tubes.
5. Category 6 Patch Panels:
   a. Manufacturers - One of the following:
      1) Hubbell Nextspeed.
      2) Siemon HD.
      3) Or Approved Equal.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

6. Patch Panels and Connectors shall meet the following (minimum) requirements:
    a. Category 6, T569A/B.
    b. RJ-45 patch cord termination: S110 UTP-STP cable termination.
    c. Capacity: 48 ports (minimum).
    d. Mounting: 19-inch rack mount.
    e. Accessories: Rear cable management bracket, individual port labels.
7. Provide patch cables as required to support all network devices. Provide four spare straight-through patch cables. Provide one spare cross over cable.
8. Fiber Patch Panels:
    a. Wall Mounted Interconnect:
        1) Application: Use for the termination of a single cable outside of cabinets, in small enclosures, or as indicated on the plans.
        2) Wall mounted fiber interconnects shall be provided as complete units including the housing, the connector panels, and the fiber connectors.
        3) Wall mounted fiber interconnects shall provide physical protection for both the incoming cable and the outgoing patch cords.
        4) Accessories:
            a) Door lock.
            b) Blanks for unused connector panels.
        5) Manufacturers:
            a) Corning Cable Systems; Wall-Mountable Interconnect Center.
            b) Or approved equal.

D. Network Racks:
1. Post Open Rack: Manufacturers
    a. Hoffman DataCom.
    b. Rittal.
    c. Or approved equal.
2. Properties:
    a. 19-inch rack mount.
    b. Side rail cable management.
    c. Constructed of 10g steel.
    d. Provided vented shelf.
    e. Velcro cable wraps.
    f. 20 Amp surge protected power strip.

E. Server Cabinets:
1. Manufacturers - One of the following:
    a. Hoffman Proline.
    b. Rittal.
    c. Or approved equal.
2. Properties:
    a. Glass front door (lockable).
    b. Perforated rear door (lockable).
    c. Perforated top with 2 cable entries.
    d. Fully welded frame.
    e. 20 Amp surge protected power strip.
    f. Velcro cable wraps.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2.3 LOCAL PLANT NETWORK AND HANDHELD DEVICES

A. Contract 2's PIC supplier has provided twelve Access Point locations to be used. PIC supplier shall assure wireless network already established will work with Biosolids System Addition and/or add additional access points as required.

B. Hardware
   1. Ruggedized Handheld Computer (provide 2)
      a. Windows Mobile OS (latest version)
      b. 128 MB DDR SDRAM
      c. 1 GB flash storage
      d. Full VGA display
      e. Touchscreen
      f. Submersible
      g. IP67 rating
      h. Operating Temperature: -22F to 140F
      i. Integrated speaker
      j. Compact Flash and Secure Digital Slot
      k. Rechargeable Li-Ion battery (provide 2 spare batteries)
      l. AC charger
      m. Deluxe case with belt clip and neck strap
      n. 1 year warranty
      o. TDS Nomad 800L or approved equal

2.4 ACCESSORIES

A. Provide duplex patch cords to connect the interface cards provided with the associated patch panels.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All racks shall be level and plumb.

B. Install Velcro wrap on all cable bundles within the network rack/enclosure.

C. All cables and equipment shall be installed in strict conformance with the manufacture's recommendations:
   1. Cables shall be installed avoiding sharp bends.
   2. Install cable using lubricant designed for cable pulling.
   3. Cable ties or other cable supports shall be installed without crimping the LAN cables.
   4. Install LAN cables without splices.
   5. Installed bend radii shall not exceed 4 times the cable diameter.
   6. Terminate all pairs at the jack and the patch panel.
   7. Install cables a minimum of 40 inches away from electrical motors and transformers.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

8. Install cables a minimum of 12 inches away from fluorescent lighting.
9. Individual pairs will be untwisted less than 1/2 inch at termination points.
10. All cables and terminations shall be labeled with cable designations as described in the specifications.

D. Each data port shall be individually labeled with its patch panel/switch port ID:
   1. Labeling must be printed - no handwritten labels will be allowed.

E. At the completion of the wiring installation, the Engineer shall be provided with the following documentation:
   1. A plan-view of the premise(s) showing the jack numbering scheme.
   2. A printed certification report for the entire wiring installation showing compliance with all ANSI/EIA/TIA specifications for data cable.
   3. Reports such as those generated by Fluke DSP cable certification equipment meet this requirement.

F. Communications Cabinets (CC) will consist of a network switch, patch panel, and power supply to be mounted in an 18” x 18” x 8” NEMA 12 enclosure. Incoming power shall be protected by surge suppression. Quantities and locations of CC to be shown in network drawing.

3.2 FIELD QUALITY CONTROL

A. LAN cable testing:
   1. Testing scope: Test all installed LAN cables.
   2. Test plan and witnessing: Obtain Engineer's approval for the test procedures as part of the submittal process. Arrange for the Engineer to witness all testing. Submit a request for witness 15 days (minimum) before the proposed test date.

B. Pre-testing:
   1. Individually test cables before installation:
      a. Before physical placement of the cable, the installer shall test each cable while on the spool with a LAN certification test device.
      b. Before the cable is installed, the installer shall check that the cable conforms to the Manufacturer's attenuation specification and that no damage has been done to the cable during shipping or handling.
      c. The test shall be fully documented and the results submitted to the Engineer and Owner.

3.3 ADJUSTING

A. Perform all firmware installations, configuration, and other set up as required to place the network into proper operation.

3.4 DEMONSTRATION AND TRAINING

A. After completion of the cable system tests and before placing the system in operation, power up all devices installed on the LAN and verify communication between the devices.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Verify that all equipment is operable on the network simultaneously. Confirm that all network device communications settings are properly configured.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes requirements for:
   1. HMI Software
   2. Loop Descriptions
   3. I/O List

1.3 REFERENCES

A. ISA S5.1, S5.2, S5.3, S5.4 - Instrumentation Symbols, Diagrams, and Identification.

B. Underwriter's Laboratories.

C. NFPA 70 - National Electric Code.

1.4 SUBMITTALS

A. Furnish submittals in accordance with Division 01, Section "Submittal Procedures".

B. Provide the following:
   1. Data sheets and catalog literature.
   2. Interconnection and interface requirements.
   3. Manufacturer's installation instructions.

C. Organize submittal in a logical manner.

D. Submit shop drawings showing color, size, features, and layout of desks and chairs to be located in the Control Room and Supervisor's Office.

E. Submit Operation and Maintenance information according to Division 01, Section "Operation and Maintenance Data" and include the following:
   1. Equipment Data: Complete descriptive literature of each piece of equipment, including a list with location, model, and serial numbers as installed.
   2. Operation Data: A description of the electrical requirements, environmental requirements, programming, adjusting, and testing required.
   3. Maintenance Data: Identify system maintenance requirements, servicing cycles, and spare part sources.
   4. Instruction Manuals: Provide complete descriptive manufacturer's literature for each piece of equipment, including a list and description of all parts of each piece of equipment.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1.5 DELIVERY, STORAGE AND HANDLING

A. Protect components against damage according to the manufacturer's recommendations.

B. Accept unit on site. Inspect for damage. Report any damage found to the Owner and the Engineer.

C. Protect equipment from extreme temperature and humidity by storing in a conditioned space.

D. Protect equipment from dust and debris by wrapping unit in dust-tight cover and storing away from construction activity.

E. Store in a clean, dry space. Maintain factory wrapping or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

1.6 WARRANTIES AND BONDS

A. Provide a warranty against defective or deficient materials and workmanship in accordance with the requirements of Division 01 Section "Closeout Procedures".

B. The equipment manufacturer shall provide a warranty against defective or deficient equipment, workmanship and materials under normal use, operation and service. The warranty shall end a minimum of one year from the date of Substantial Completion and include coverage for computer, monitor, keyboard, and mouse. The warranty shall be in printed form and apply to all similar units.

1.7 ENVIRONMENTAL CONSIDERATIONS

A. Ambient Operating Temperature: 50 degrees F to 95 degrees F.

B. Storage Temperature: 50 degrees F to 110 degrees F.

C. Humidity: 8 percent to 90 percent.

D. Electrical Supply Voltage: 120 V AC, ±10 percent, 60-Hz.

PART 2 - PRODUCTS

2.1 GENERAL DESIGN

A. Provide a SCADA System based on a distributed design where the major components are interconnected by a high speed network which employs client/server architecture as indicated on the Drawings.

B. Provide an I/O Server system which functionally divides the major system tasks (i.e., I/O, Alarm, Report, Historian, and Display computing) such that each task performs its own processing.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

C. All host, data acquisition, historian, file server, and operator interface functions shall be performed by redundant SCADA I/O Servers located in the Control Room.

D. Provide redundant design and configuration such that in case of a primary server failure, the standby server shall automatically assume the primary role without loss of data. In addition, the operator display clients should be automatically notified that a failure has occurred. When the primary server is brought back online, it should be automatically re-synchronized without requiring operator action to ensure the absence of gaps in the recorded historical database.

E. The system shall allow multiple forms of communications with remote devices with a communication program serving each kind of remote device. Integrating new types of Field Control Units in the system shall only require a communications program specific to that hardware interface.

F. Future communications with remote units shall be supported via leased line, microwave, or radio.

G. Local or in-plant interface shall be supported through a communications port interface.

2.2 I/O SERVERS / OPERATOR INTERFACE WORKSTATIONS

A. To be provided by BGMU

2.3 PORTABLE COMPUTER:

A. To be provided by BGMU

2.4 PRINTERS:

A. To be provided by BGMU

2.5 SOFTWARE

A. Overview: The SCADA system shall consist of a SCADA software package, personal computers, and industry standard networking hardware. The SCADA system will read and write data to field controllers, archive historical history, and provide graphics screens and reports so that operators, supervisors, and maintenance personnel can quickly and easily maintain and operate the system.

B. The SCADA software package proposed shall be based on one of the following Microsoft operating systems:
   1. Windows XP
   2. Windows Vista
   3. Microsoft SQL Sever 2005
   4. Windows Server 2008

C. The SCADA software shall support development and runtime implementations on all of these operating systems. The SCADA software must support implementations involving a combination of any of the previously listed operating systems, for example, the SCADA

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

server may be implemented on a 2003 Windows server platform, the clients on a Windows 98 platform, and the development performed on a Windows NT platform. It shall be also be possible to run the SCADA software as a service under Windows.

D. The SCADA software shall be configurable as a single global database regardless of the number of nodes in the system. It shall be possible to make configuration changes to the global database at any node on the system in a manner that is completely transparent to the user. Each SCADA node shall have the option of either having the database locally to reduce network traffic or accessing the database remotely in a file serving environment on networks with high bandwidth capabilities.

E. Software licenses must include a 2 year subscription to Gold Support. This allows website access, assistance from technical support engineers via phone or e-mail, and free upgrades to the latest software versions.

2.6 CONNECTIVITY AND COMMUNICATIONS TO FIELD DEVICES

A. The software shall employ I/O (Input/Output) Servers to read and write variables to and from field controllers (PLC's, RTU's or DCS's). The I/O Servers shall manage the reading and writing of data from the I/O Device Subsystem and shall provide the data on request to any client on the Network.

B. The I/O Server machines shall have the same graphical display capabilities of any other display station on the network.

C. The I/O Servers shall maintain a cache of data for a configurable time, such that requests from multiple display station clients do not generate unnecessary requests to the field controllers, and will read from the I/O Server cache and not directly poll the field devices.

D. The software shall support Primary and Standby I/O Servers to provide automatic redundancy in the event of a Primary I/O Server failure without any user intervention or special scripting required. This switch over from a Primary to a Standby I/O Server shall be accomplished in under 1 second when a communication failure is detected. The system shall support automatic switching of I/O communications to up to 5 standby I/O servers for a single field controller if installed at a latter date.

E. The software shall support redundant communication paths to field controllers (i.e., a primary Ethernet path and a back up serial path), and provide automatic changeover to the standby path in the event of a communications failure.

F. The software shall support communication to field controllers that have primary and standby processors. If a primary processor fails, the software shall automatically detect the failure and switch to communicating to the standby processor. This shall require no user intervention, special scripting, or use of redundant tags within the software.

G. In-built diagnostic alarms shall be provided with the system that will automatically notify the operator of the failure of any communications path.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

H. As a minimum, the software shall be provided with the following communications drivers for field controllers at no extra charge:
   1. Modbus Serial
   2. Modbus over Ethernet (TCPIP)
   3. DF1 Driver
   4. Allen Bradley Controllogix Ethernet Driver
   5. Allen Bradley PLC5 DH+ driver and Ethernet Driver
   6. Allen Bradley SLC500 DH+ driver and Ethernet Driver
   7. Profibus Driver
   8. Siemens S5 and S7 family of controllers Ethernet Driver
   9. GE Fanuc 90/30 and 90/70 Serial and Ethernet Drivers

I. As a minimum, the software shall be provided with the following connectivity options to 3rd party programs or databases at no extra charge:
   1. OPC Client
   2. OPC Server
   3. ODBC Client
   4. ODBC Server
   5. DDE Client
   6. DDE Server
   7. Open API

J. The API shall allow third party applications written in C, C++, C#, VBA, Pascal, or Fortran access to tag, alarm, and trend data. This API shall support the standard SCADA security model provided and should allow both read and write access to the SCADA data.

K. The system shall have in-built support for scheduling dial up communications to remote field devices. The dial up communications shall support a pre-set polling schedule where a user configures a telephone number and a time schedule. This schedule must be able to be overridden by an “on demand” poll at runtime. The configuration shall be form based for ease of configuration and not require user scripting.

L. The system shall support remote field devices initiating an unsolicited dial back into the system. This typically happens during a field alarm event. The system shall automatically identify the communications protocol of the field device dialing in, establish communications, and obtain the relevant data.

M. For remote field devices, if the communications link fails for whatever reason, on re-establishment of the remote link, all historical alarm, event, and trend data archived by the remote field device (RTU) shall be automatically backfilled into the native SCADA alarm and trend history files. The data shall be fully viewable via the standard SCADA alarm and trend viewers.

N. The SCADA software vendor shall have a package available to users that provides the facility for user-written device drivers. The package shall include an examples disk including source code for various types of working drivers that are similar to the requirements of the user (e.g. Serial Driver, TCP/IP Driver, report by exception, proprietary board, etc.).

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2.7 SECURITY

A. Security shall be fully integrated into the SCADA system to allow only users with appropriate security levels access to individual parts of the system. Security must be checked on the server side and passwords must be encrypted.

B. The software shall support an unlimited number of users. For each user, it shall be possible to define a password, privilege level(s), and areas of a plant that the user has view or control privileges over.

C. The software shall monitor and log each control action of each user. This logging shall incorporate all operator control actions, including logging in and out of the system. The sequence of actions shall be viewable via an event viewer window within the SCADA package and also stored in an external open file format (e.g., .txt, .csv, .dbf, and .sql) for later analysis.

D. A user shall automatically be logged out of the SCADA software after an adjustable time period. However, logging out a user will not shut down the system; the system shall revert to a view-only security status.

E. It shall be possible to define a minimum of 8 privilege levels for each user. The software shall check to ensure that the user logged on has the correct privilege level for all functions. If the user does not have the correct privilege for a function or object, the software shall display a message informing the operator of insufficient privilege.

F. For each graphic object, it shall be possible to assign the object to a plant area, define the object's privilege level, and define whether operator input is enabled or disabled or whether the object will be visible or not based on the operator’s current privilege levels within the plant area.

G. The software shall have a mechanism to restrict access to different areas of the plant for each individual user or group of users. It shall be possible to define a minimum of 255 different plant areas.

2.8 GRAPHICAL DISPLAYS

A. The number of graphic displays capable of being added to the system shall not be limited by the software.

B. The graphical display pages shall be capable of a minimum of 2000 analog variables, with real time updates of less than 500 ms (for all data to appear or change on the page).

C. Graphics pages shall be capable of automatically re-sizing to match the screen resolution of the computer on the network without shutting down the SCADA software and without requiring multiple copies of graphic pages.

D. The graphics system shall support a screen resolution of up to 4000 x 4000 pixel resolution.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

E. The graphics system shall support full 32 bit (65 million color) graphics.

F. The software shall have the capability to provide pop-up windows for trends, loops, and device status and device control by clicking on hot spots or objects on the main graphics page. One-hundred (100) simultaneously opened popup display windows shall be supported by the graphics display system.

G. All graphics displays shall include the page name, current time, and date together with details of the last 3 alarms that have occurred.

H. The user shall be able to navigate around the graphics system utilizing a variety of navigation methods.

I. Hot keys shall be available to provide quick links to specific graphics pages from the Windows keyboard.

J. Windows style navigation menus shall be provided allowing access to any configured page in the system from any other page.

K. The graphical displays shall be configured with “hot spots” where as a user can click on the area and drill down into a detailed view (if available) of the plant area.

L. The graphics configuration environment shall support the following graphical dynamic objects as a minimum:
1. freehand lines
2. straight lines
3. poly-lines
4. rectangles
5. ellipses
6. pie slices
7. text
8. 3D Pipes

M. Each dynamic object shall have properties that allow the object to be modified according to the value of either a tag or an expression.

N. It shall be possible to group together dynamic graphic objects and then apply dynamic properties to the group as a whole, rather than each individual object.

O. The SCADA software shall be an ActiveX container and allow for insertion of ActiveX objects into standard graphics pages. It shall be possible for the SCADA software to interact with ActiveX objects in the following ways:
1. Dynamically change properties of an ActiveX object via a tag from an I/O device.
2. Dynamically change properties from SCADA software high level language.
3. ActiveX object to trigger actions in the SCADA software based on events in the ActiveX Object.
4. ActiveX property values can be read by the SCADA software.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

P. The software shall have the capability of supporting full screen, live camera video images and video from disk (MPEG, AVI) concurrently with screen displays with no interruption to data collection. Update times in the Process Control System windows shall not be affected.

Q. If communications to a particular I/O point has failed for any reason, then wherever that data is displayed the software shall post a visual indication that the point is not valid.

R. The software must be designed with the ability to make changes to the graphics while the system is running. Shutting down the system shall not be required to make graphics changes.

S. The Contract 2 graphical screens are as follows (at a minimum):
1. Plant Overview
2. Headworks Building
3. Headworks Outside
4. SBR A-1
5. SBR A-2
6. SBR B-1
7. SBR B-2
8. SBR South Building
9. SBR North Building
10. UV
11. Post Aeration
12. Effluent Water
13. Solids Building
14. Polymer System
15. Auger System
16. Septage Receiving
17. Generators
18. Tie in existing lift station pages

T. Additional graphical screens to be provided are as follows:
1. Biosolids Cake Feed System
2. Dryer System
3. Biosolids Silos

2.9 CLIENT SOFTWARE

A. Display clients shall connect to the individual station servers to allow personnel on the network to view graphics pages, alarms, and trends from all the compressor stations simultaneously.

B. Response times shall be under two (2) seconds to access any real time data on the network.

C. The system shall support casual web browser clients so that personnel on the WAN can have access to the system with the correct security settings.

D. The web browser client shall provide identical functionality to the standard client software including, but not limited to, graphics displays, trend pages, alarm pages, and system security.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

E. The web browser client shall support view and control capabilities, controlled by both login security and license types.

F. The web browser client shall not require any additional engineering or specialized software. The standard graphics pages, alarm pages, and trend pages used for operator display stations shall be available via the web browser client without any additional engineering requirements.

G. Browser clients shall support page changes of under two (2) seconds and data updates of under 500 ms on the corporate WAN.

2.10 ALARMS & EVENTS

A. The number of alarms supported shall not be limited by the software. A minimum of 100 million alarm summary events shall be stored in the native trend archive to recall through standard trend display screens.

B. The software shall be integrated such that an alarm acknowledged on one operator station shall be globally acknowledged, and as such, shown as acknowledged on all operator stations. This shall be configured as one common database, with no other programming necessary to enable global acknowledgment of alarms from any PC on the network.

2.11 ANALOG ALARMS

A. The SCADA software shall monitor analog and discrete variables and calculated conditions and determine if the variable is in an alarm condition.

B. For each analog tag, an alarm for each of the following conditions shall be assignable:
1. LOW-LOW
2. LOW
3. HI
4. HI-HI
5. Deviation LO
6. Deviation HI
7. Rate of Change

C. All analog alarm conditions shall have adjustable dead bands and delay timers to minimize nuisance alarms. All analog alarm properties shall be adjustable without the need to shut the system down.

2.12 DIGITAL ALARMS

A. For each discrete tag, an alarm for each of the following conditions shall be assignable:
1. Variable ON
2. Variable OFF

B. Discrete alarms shall have the capability of time stamping to enable tracking to a precision of one (1) millisecond.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2.13 MULTI-DIGITAL ALARMS

A. It shall be possible to simply configure alarms that are based on a combination of discrete tags, and any state may be configured to be an alarm. In addition if the Multi-Digital Alarm is active in one alarm state and changes to another alarm state then it shall re-alarm.

B. Two state alarm:

Variable 1 State	Variable 2 State
OFF	OFF
OFF	ON
ON	OFF
ON	ON

C. Three state alarm:

Variable 1 State	Variable 2 State	Variable 3 State
OFF	OFF	OFF
OFF	OFF	ON
OFF	ON	OFF
OFF	ON	ON
ON	OFF	OFF
ON	OFF	ON
ON	ON	OFF
ON	ON	ON

2.14 ALARM DISPLAY

A. It shall be possible to display or acknowledge any alarm and/or the most recent alarm on any page.

B. The software shall provide multiple levels of alarm priorities or categories. The priority of an alarm shall be identifiable by the color of the alarm message on the screen. The color coding of prioritized alarm messages shall be configurable by engineers.

C. Sound indication for each alarm category shall be configurable. This must be possible at each node. It shall be possible to have the alarm sound either by internal or external speaker. The sound indication shall support the playing of any standard .WAV file.

D. The software shall be provided with a standard alarm display page that can be user modified. The standard alarm page shall have the capability of scrolling alarms up and down the page and for acknowledgment of individual alarms or all the alarms on the viewable page.

E. It shall be possible to display the following information for each alarm as it appears on an alarm display page:
   1. Alarm Tag Name
   2. Alarm Description
   3. Value of the Variable

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

4. Trip point
5. Alarm Status - Disabled, Acknowledged, Unacknowledged
6. Alarm Category or Priority
7. Alarm Priority
8. Time & Date
9. Privilege
10. Category
11. Operator Comments
12. Value of any Tag or result of any calculation.

F. It shall be possible to display each alarm status in a different color (including flashing colors) dependent on whether the alarm is Active Unacknowledged, Active Acknowledged, Acknowledged Cleared, Unacknowledged Cleared or Disabled.

G. The alarm display shall support both proportional and fixed fonts with all alarm fields displayed in properly aligned columns.

H. It shall be possible to disable alarms on an individual basis, by page, by alarm category, or all alarms. When an alarm is disabled, the alarm will be displayed on a disabled alarms page so that every user of the system can easily determine which alarms have been disabled.

I. The software shall allow for operator comments to be attached to any alarm when it is acknowledged or at a later time. These operator comments shall either be displayed with the alarm or displayed by clicking on the alarm.

J. It shall be possible to automatically display any graphic display when an alarm occurs or to dynamically change the appearance of any graphical object based on whether an alarm is On, Off, Acknowledged, Communications Error, or Disabled.

K. The alarm display shall have a mechanism for operators to dynamically define filtering of alarms by alarm name, tag name, date /time range, state, or type.

L. The alarm screens shall be as follows (at a minimum):
1. WWTP Plant Hardware Alarms
2. WWTP Plant I/O Alarms
3. Lift Station Alarms

2.15 ALARM LOGGING

A. For each alarm category it shall be possible to define a different method of logging alarms. It shall be possible to define if alarms are to be logged when the alarm transitions to ON, OFF, or Acknowledgement.

B. The alarms shall be able to be logged to a designated printer, disk file, or database with alarm text, time, and date labels. Alarms shall be printed or filed in a user-configurable format.

C. The SCADA software shall allow logging to any printer on the network. The software shall be able to redirect printing to another printer while the system is online.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

D. Alarms that are logged to disk shall be available for viewing while the system is online or offline without causing any interruption to data collection. The number of alarms logged to disk shall not be limited by the software. The alarm logging function shall be capable of logging an instantaneous burst of at least 4000 alarms without losing a single alarm.

2.16 ALARM REDUNDANCY

A. All alarm calculations and management shall be performed in the Primary Server. The software shall automatically ensure that if the Primary Server fails, all alarm functions shall continue to operate normally in the standby server. The software shall automatically generate a diagnostic alarm to indicate that the Primary or Standby Server has failed. Adding, deleting, or modifying alarms shall not require any changes to the software that handles the redundancy. On restoration of a failed server, the historical alarm history must synchronize between the Primary and Standby servers so that there are no mismatches in historical alarm history.

2.17 TRENDS

A. The number of trends collected shall not be limited by the software.

B. The software shall be capable of logging historical trend information at configurable sample periods from one (1) millisecond to 24 hours.

C. Trend data shall be stored in a circular file system with the number of files, the size of each file, the sample period, file location, privilege, and area being user definable individually for each trend. File names and paths shall support file names up to 255 characters in length.

D. Every tag defined in the system configuration (digital or analog) shall be trended. Each trend shall contain a minimum of seven (7) years historical data at a ten (10) second sample rate. The trends shall be maintained online for operator call back without the need to backup or restore history files.

E. Out of the box, each operator and login shall be able to see their own fully- customized trend pages. These pages must be customizable on line by each user in a drop-and-drag manner. Any setting available to be made in a configuration environment shall be available to the user to modify the trend graphs in run time. These include the color, scaling, and pen selection, for example.

F. Trend displays shall comprise line graphs with time on a linear, continuous, horizontal or vertical axis and the trended variable on the vertical or horizontal axis. Resolution of each graph shall be to within 0.1% of full scale.

G. Where more than one variable is displayed on the same graph, the pen color of each variable and associated information shall be displayed in different colors.

H. Each trend graph shall be capable of displaying a minimum of 32 trend pens with adjustable time base to one (1) second samples and shall be capable of viewing the entire archived trend history.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

I. Historical system alarms shall be able to be overlaid on the trend pages showing the alarm state transitions.

J. A standard graphics page shall support a minimum of 100 individual trend windows embedded within the display so that an overview of multiple site levels can easily be produced.

K. It shall be possible to trend multiple pens or multiple plots of the same pen over various time spans for comparison purposes (i.e., previous day to today's results).

L. Each pen shall display individual ranges and engineering units. Each pen shall be scalable for display purposes independent of another pen displayed on a page.

M. The software shall include the capability to pan backward and forward within a selected time range to read the exact value of any displayed variable by selecting a point on the graph or chart. The system shall display historical information as far back in time as desired, with all information being displayed within one (1) second.

N. The trend display shall have a slide wire that can be moved over the page that will provide indication of the date, time, and value at the intersection of the slide wire and the trend point. A minimum of two (2) such slide wires shall be supported for each trend page.

O. The software shall provide "zoom" and "pan" facilities for both the trended variable range and the time axis range. The "zoom" facility shall allow an operator to compress or expand the axis range whilst the "pan" facility shall allow an operator to shift the origin of the axis. The software shall allow a user to define any zoom area by dragging a mouse across the trend.

P. The software shall make trending data from the historical database available for export to disk files or external databases. It shall be possible to define the section of the trend to be exported by clicking and dragging the mouse across the trend. Data shall be exported to .csv, .dbf or .txt formatted files. It shall also be possible to export any portion of the historical trend database via .odbc, .dde, .dbf, .csv, and.txt formats.

Q. The software shall provide the capability of printing out either instantaneous or historical based trends on the designated trend printer. The software shall have the capability to perform a trend print (not a screen print). The trend print function shall print to the printer using objects, not bitmaps. The trend printout shall include the engineering units and ranges for each trend, a trend grid, and the time base for each trend. Each trend shall be identified by a different line style (i.e., dotted, dashed, solid, etc.) on monochrome printers and a different color for color printers.

R. Trend Redundancy: Trend collection and management shall be performed utilizing primary and standby servers; both shall contain all the historical trend information. If the primary server fails, then the standby server shall ensure all trend functions continue to operate. Upon restoration of the primary server, the standby server shall automatically update the primary server such that there are no gaps in the historical trend data. No operator involvement shall be required. Failure of the primary and standby servers shall be monitored such that a failure at anytime will produce a diagnostic alarm.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

S. Trend screens shall be as follows (at a minimum):
   1. General Analog Trending
   2. Electrical Trending
   3. Trend Page for comparing SBR Basins

2.18 DEVELOPMENT ENVIRONMENT

A. The SCADA software shall include an integrated development package utilizing menu driven, fill-in-the-form style configuration to develop the runtime database.

B. All development functions shall be available at every node on the system and shall allow multiple users working on different nodes to simultaneously modify the same master database. A minimum of five (5) simultaneous developers shall be supported.

C. Comprehensive online help shall be available for all development functions; the online help shall contain all information provided in the hard copy manuals.

D. A utility shall be included to back-up or restore an entire database including all graphic displays, configuration data, and source code, via a simple point-and-click method. The backup/restore utility shall prompt the user prior to overwriting any existing files. The backup/restore facility shall employ automatic file compression/ decompression.

E. Importing of tag definitions from the field controller configuration/programming packages shall be included as a standard feature such that upon change of a definition in the I/O device, tag names, addresses, ranges, etc. will automatically be imported into the SCADA software database. In addition to automatic tag definition importing it shall be possible to manually initiate the import of tag definitions at any time.

F. The tag import function shall be user configurable such that a user can specifically define which definition fields must not be overwritten, or user-defined rules can be applied to define how the import will operate. The import function shall support generic OPC data sources and CSV file imports in conjunction with native field controller programming software database imports.

2.19 GRAPHICS DEVELOPMENT

A. The graphics builder shall be interactive and menu-driven, requiring no programming.

B. The software shall have the ability to directly import graphics and text in the following file formats:
   1. Autocad DXF
   2. Windows BMP
   3. Windows Meta File WMF
   4. GIF
   5. TIF
   6. PCX
   7. TXT
   8. DIB and RLE

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

C. The graphics builder shall be an ActiveX controller allowing ActiveX objects to be inserted and edited in a visually interactive manner. It shall be possible to connect ActiveX properties to tags, allowing read/write between properties and tags without the need for scripts or code. ActiveX objects must have the same security as native graphics objects allowing ActiveX objects to be visible or hidden based on the privilege level of an operator.

D. The graphics builder shall be capable of creating screens composed of both static and dynamic objects. To create these objects, the software shall provide sample screens and a set of standard shapes in a library. The developer shall be able to include these symbols by reference or create new symbols/objects.

E. The graphics builder shall provide the following tools:
1. Grid and guidelines (which can be displayed on screen) together with snap to grid and snap-to guidelines to assist in aligning objects precisely.
2. Horizontal and vertical alignment together with even spacing.
3. Send to front/back, bring forward one layer, and send backward one layer.
4. Bitmap editing including pixel drawing, image resizing, and image cropping.
5. Color swap from one color to another for a group of selected objects including colors within a bitmap. Color swap shall also include swapping a range of colors such as all reds to all greens so that shaded objects can be color changed without redrawing or re-rendering.
6. Editing of nodes on polylines that provides the addition or removal of nodes plus movement of nodes.

F. The graphics builder shall support an unlimited "undo" and "redo" feature.

2.20 HIGH LEVEL LANGUAGES

A. Firstly, the software shall not need any custom code to achieve standard functionality.

B. The software shall provide an integrated high level language specifically designed for SCADA applications and shall be inherently multi-tasking and multi-threading.

C. The software shall contain fully integrated Visual Basic (VB) scripting.

D. The scripting language(s) shall provide access to all field tags, alarms, graphics displays, databases, and ASCII files. The languages shall include functions with clear and precise syntax. The languages shall support user written functions and function libraries supported by the computer's operating system. The language shall have the capability to export or import data from other applications.

E. The integrated SCADA language shall allow creation of calculated (inferred) variables based upon formulae including constants, measured variables, and other calculated variables. All facilities available for logging, reporting, trending, monitoring, controlling, alarming, and displaying measured variables shall also be available for calculated variables.

F. The integrated SCADA language shall support the following mathematical and Boolean operators:
1. Addition

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2. Subtraction
3. Division
4. Multiplication
5. AND
6. OR
7. XOR
8. NOT
9. Greater Than, Less Than, Equal, and Parenthesis.

G. The integrated SCADA language shall provide the following mathematical functions:
1. Absolute
2. ArcCos
3. ArcSin
4. ArcTan
5. Cos
6. DegToRad
7. Exponent
8. Factorial
9. HighByte
10. HighWord
11. Ln
12. Log
13. LowByte
14. LowWord
15. Max
16. Min
17. Pi
18. RadToDeg
19. Random
20. Round
21. Sign
22. Sin
23. Sqrt
24. Tan

H. Any functions shall be capable of running forever without restricting other SCADA functions from running correctly.

I. The integrated SCADA language shall permit users to create their own functions and integrate them in the language. Functions shall be reusable without the need to copy and paste. It shall be possible to call the same function multiple times from different locations, with different parameters simultaneously.

J. It shall be possible to run functions automatically on start up, on page entry, on page exit, while a page is open, on button down, while button down, embedded in reports, alarm on, alarm off, on any keystroke, any keyboard entry on any mouse button click, etc.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

K. The software shall have the ability to test and debug the languages online. The debug tool shall display the source code as it executes with a pointer identifying the current line of code being executed, the value of local and global variables, and any output as the user single-steps through the code. The ability to set break points, single-step, step over sub functions, step out of sub-functions, and continue execution shall be included.

2.21 SOFTWARE

A. The software shall be CitectSCADA version 7.1 or latest current version.

2.22 ANCILLARY NETWORK COMPONENTS/CONFIGURATION

A. Provide interconnection of the SCADA I/O servers, operator interface workstations, printers, and field control units using secure, error free communication path. IEEE 802.3, 802.3u, and 802.3z shall be adhered to for all communications between microprocessor controlled devices.

B. All associated communication equipment required to build functional networks including cable, connectors, amplifiers, switching components, routers, and network interface cards shall be provided, even if not explicitly called out by this specification.

C. Provide network configuration to ensure secure and error free communication between all connected nodes as indicated on the Drawings.

2.23 STANDBY POWER AND SURGE PROTECTION

A. To be provided by BGMU.

PART 3 - EXECUTION

3.1 DEVELOPMENT GUIDELINES

A. Functional Specification
   1. The PIC supplier is required to provide a functional specification (similar to the supplement provided for existing system) for approval during the design stage of SCADA interface. This shall be approved by the Owner and Engineer before start-up may occur.
   2. It is the intent of the Owner to have a consistent SCADA platform in the water treatment plant (existing), the distribution and collection system (existing), and the wastewater treatment plant (new). The functional specification example provided should be considered as a template for the graphical layout and expectations of the Owner.
   3. It is imperative that communication and access of all systems be available at both plants and the BGMU Utility Office.
   4. Control of the existing distribution and collection system must be integrated into the system.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

5. All graphic screens shall be preapproved by both the Engineer and Owner before being integrated into the control system. It is the responsibility of the PIC supplier to engage BGMU management and operators for suggestions in the design and functionality of system.

3.2 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify that each location is ready to receive work.

C. Coordinate installation with the Owner.

3.3 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Replace damaged components as directed by Engineer.

3.4 INTERFACE WITH OTHER PRODUCTS

A. Provide all required cables, cords, and connectors for interface with other control system components.

3.5 FIELD QUALITY CONTROL

A. Provide field inspection and testing under provisions of Division 01 Section "Quality Requirements".

B. Field Tests: Verify specification performance criteria and other tests as recommended by manufacturer.

3.6 TRAINING

A. Training personnel shall be intimately familiar with both the control system and the plant process. The PIC supplier shall provide trainers that are familiar with the designed operations of the plant and how the control system executes the operation.

B. A preliminary operator training shall be held during the SCADA final design stage to gather operator feedback and allow smooth transition into automated control of plant. The PIC supplier shall supply operator workstations at the PIC supplier office that will simulate control of the plant, and allow for a "real" control environment. A minimum of two (2) days will be required.

C. Two operator training sessions shall be held 1 to 2 weeks before system startup. A minimum of three (3) days for each session will be required.
   1. Plant operator training shall be held at the convenience of the Owner. The PIC supplier shall be prepared to hold this training during the day, late at night, or very early in the morning to accommodate the Owner's shift schedule.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2. Plant operator training shall be structured specifically for operations type personnel. Training personnel shall be prepared to show the operators how to operate the plant from the control system level. Additionally, such topics as copying graphic displays, signing-on the system, creating graphic generated trends, etc. shall be discussed.
3. The PIC supplier shall have teaching aids available for distribution during plant operator training sessions.
4. Fifty percent of all plant operator field training shall be "hands on" utilizing the installed control system to the fullest extent possible.

D. The PIC shall have two (2) follow up training sessions, each for one (1) day. The first to be held one (1) week after the plant is being fully controlled by the automated system. The next is to be held one (1) week after the first. The intent is to allow the operators to use and become acquainted with the system and to note any areas where additional training might be appropriate. The one (1) day visits may be split for different times during the day to allow all operators to participate. This is not to be used for warranty issues. Training shall be held at the convenience of the Owner.

E. A final training session shall be held two (2) months after system start-up for two (2) days. The intent is to give operators time to take ownership of the system and assist operators in any changes or reinforce any areas of training they feel is needed. The two (2) day visit may be split for different times during the day to allow all operators to participate. This is not to be used for warranty issues. Training shall be held at the convenience of the Owner. Final O&M manuals incorporating any control changes are to be delivered at this time.

3.7 SUPPLEMENTS

A. The supplements listed below follow "End of Section" and are part of this Specification.
1. Loop Descriptions.
2. PLC Input/Output List.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

The "Loop Descriptions" forms a part of the Construction Documents and is attached.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1.1 SLUDGE DRYING AND DISPOSAL

A. Wet Cake Hopper Level Monitors (BSCH-7101, BSCH-7102, BSCH-7201, & BSCH-7202)
   1. System will continuously monitor the wet cake elevation in the wet cake hoppers (2 sensors per hopper, total of 4 sensors). The sensor will be located between the conveyor discharge points into the hopper. The hopper equipment supplier will provide the sensors.
   2. The system will transmit the signals to Wet Cake Hopper Control Panel (BSCHCP-7010), and Communication Cabinet 4 (CC4). A high alarm signal will be sent to Wet Cake Hopper Control Panel (BSCHCP-7010), Centrifuge Package panel (SPCCP-4001, SPCCP-4002, and SCPCP-4003) and Communication Cabinet 4 (CC4). The set-point for the alarm will be adjustable. The range will be 0 to 10 ft. Initial set-point for the alarm will be 8 ft.

B. Wet Cake Hopper Load Cells (BSCH-7104 & BSCH-7204)
   1. System will consist of load cells mounted under each wet cake hopper support to continuously monitor the weight of the wet cake discharged into the hoppers (6 load cells per hopper, total of 12). The load cells will be provided by the hopper equipment supplier. If equipment supplier requires more than six support legs per hopper, equipment supplier to provide additional load cells for the additional number of supports.
   2. The load cells will be zeroed out at the tare weight of the hoppers, platforms, conveyors, etc. The totalized weight of the load cells at each hopper as sludge is added into the hopper will be recorded as the hopper weight.
   3. The system will transmit the signals to Wet Cake Hopper Control Panel (BSCHCP-7010) and Communication Cabinet 4 (CC4). A high alarm signal will be sent to Wet Cake Hopper Control Panel (BSCHCP-7010) and Communication Cabinet 4 (CC4). The range will be 0 to 120 tons (total). The initial set-point for the alarms will be 50 tons.

C. Wet Cake Hopper Live Bottom Conveyors (BSBC-7121. BSBC-7122, BSBC-7221 & BSBC-7222)
   1. There are two live bottom conveyors located in each hopper. The conveyors will move the wet cake to the cake pump feed hoppers. The conveyor will have four variable frequency drives (VFDs) to control the cake output to cake pump hoppers.
   2. The conveyors will have a Hand-Off-Auto selector switch located at the Hopper Conveyor Control Panel (BSCHCP-7010). In Hand they will run continuously and the conveyor speed will be set at the VFD panel. In Auto they will be controlled by the Cake Pump Hopper Load Cells (BSP-7135 & BSP-7235). A signal will be transmitted from the Cake Pump Panel (BSPCP-7020) to the respective live bottom conveyors to increase or decrease the conveyor speed to maintain a steady feed to the Wet Cake Pumps.

3. If the Cake Pump Hopper Load Cell detects excessive material in the hopper the conveyor will stop and an alarm status will be activated.
4. The system will transmit the status signals to Cake Hopper Control Panel (BSCHCP-7010) and Communication Cabinet 4 (CC4). The status signals will include the On status and the Failure alarm for each motor.

D. Wet Cake Hopper Live Bottom Conveyors Motion Failure Switches (BSBC-7151, BSBC-7152, BSBC-7161 & BSBC-7162)
1. Magnetic motion failure switches will be provided for each conveyor to determine if the conveyors are rotating. The hopper equipment supplier will provide the switches.
2. The system will transmit the signals to Cake Hopper Control Panel (BSCHCP-7010) and Communication Cabinet 4 (CC4). The status signals will include the On status and the Failure alarm for each drive.

E. Cake Pumps (BSP-7130 & BSP-7230)
1. There are two Cake Pumps provided to transfer wet cake to either the dryer or to the wet cake truck loading. The pumps will be controlled from the Cake Pump Control Panel (BSPCP-7020).
2. Each pump has a VFD to control the pump speed and output. Each pump is provided with a Hand-Off-Auto selector switch. In Hand they will run continuously and the pump speed will be set at the VFD panel. In Auto they will be controlled by the Dryer Feed System.
3. If the dryer is not in operation and sludge is to be pumped to the truck loading station the pumps will be operated in the Hand mode with the pump speed set at the VFD panel.
4. When the dryer is in operation, the cake pumps will be started and their speed set at the Dryer Control Panel (BSDCP-7030).
5. Temperature sensing elements are provided at the cake pump motors. If an adjustable high temperature is detected an alarm signal will be sent to Cake Pump Control Panel (BSPCP-7020), Dryer Control Panel (BSDCP-7030) and Communication Cabinet 4 (CC4).
6. The system will transmit the pump status signals to Cake Pump Control Panel (BSPCP-7020), Dryer Control Panel (BSDCP-7030) and Communication Cabinet 4 (CC4). The status signals will include the On status and the Failure alarm for each motor.

F. Cake Pump Hopper Load Cells (BSP-7135 & BSP-7235)
1. System will continuously monitor the wet cake weight in the wet cake pump hoppers (2 load cells). The system will control the Wet Cake Hopper Live Bottom Conveyor VFDs. The system will increase or decrease the conveyor (either BSBC-7121 & BSBC-7122 or BSBC-7221 & BSBC-7222) speed to maintain the sludge cake weight in the cake pump hopper.
2. The system will be provided by the Wet Cake Pump supplier.

3. Each load cell will be zeroed out at the tare weight of the pump, hopper, etc. The totalized weight of the load cell as sludge is added into the hopper will be recorded as the wet cake pump's hopper weight.
4. The system will transmit the signals to Cake Pump Control Panel (BSPCP-7020) and Communication Cabinet 4 (CC4). A high alarm signal will be sent to Cake Pump Control Panel (BSPCP-7020). The set-point for the alarm will be adjustable. The range will be between 0 to 1,000 pounds. Initial set-point for the alarm will be 500 pounds.

G. Cake Pump Discharge Pressure (BSP-7136 & BSP-7236)
1. System will continuously monitor the pump discharge pressure to the dryer. The system will be provided by the Wet Cake Pump supplier.
2. The pressure signal will be transmitted to Cake Pump Control Panel (BSPCP-7020), Dryer Control Panel (BSDCP-7030) and Communication Cabinet 4 (CC4). A high alarm signal will be sent to Cake Pump Control Panel (BSPCP -7020) and Communication Cabinet 4 (CC4). The set-point for the alarm will be adjustable. The range will be between 0 to 250 psi. Initial set-point for the alarm will be 200 psi.

H. Slip Ring (BSSR-7140 & BSSR-7240) and Booster Pump System (BSSRP-7310)
1. If the cake pump discharge pressures increase it may be helpful to inject water into the piping. The slip ring system (BSSR-7140 & BSSR-7240) will be used to relieve pressures on the cake pumps. A small amount of plant water will be fed into an injection ring on the discharge side of the cake pump.
2. To overcome the cake pump system pressures, a booster pump (BSSRP-7310) will pump plant water into the slip ring.
3. The booster pump will have a Hand-Off-Auto selector switch at the Cake Pump Control Panel (BSPCP-7020). In Hand it runs continuously. In Auto it will start when one of the cake pumps is operating.
4. A solenoid valve (BSSRSV1-7141 or BSSRSV1-7242) is provided in the booster pump discharge piping to each slip ring. If the cake pump is operating the solenoid valve will open to the respective cake pump discharge piping. If the booster pump is Off the solenoid valve will remain closed.
5. Rotometers (BSSR-7145 & BSSR-7245) are located in the pump discharge piping to each slip ring. The water flow rate can be adjusted at the rotometer.
6. The slip ring system will be provided by the Wet Cake Pump supplier.
7. The system will transmit the status signals to Cake Pump Control Panel (BSPCP-7020), Dryer Control Panel (BSDCP-7030) and Communication Cabinet 4 (CC4). The status signals will include the On status and the Failure alarm for the motor.

I. Cake Piping Air Compressor (BSAC-7320)
1. An air compressor is provided to push the wet cake out of the cake piping when it is necessary to completely empty the piping. This system is provided

mainly for empting the piping to the cake truck loading area to prevent freezing in the winter.

2. The air compressor will be provided by the cake pump equipment supplier.
3. The compressor will have a Start-Stop pushbutton at the Cake Pump Control Panel (BSPCP-7020).
4. Solenoid valves (BSACSV1-7321 or BSACSV1-7322) are provided in the compressed air piping to each wet cake pump discharge line. When the sludge line to the truck loading area is to be blown out the respective solenoid valve will have to be opened. "Open-Close" selector switches are provided on the cake pump control panel (BSPCP-7020). If the air compressor is Off the solenoid valves will remain closed.
5. The system will transmit the status signals to Cake Pump Control Panel (BSPCP-7020) and Communication Cabinet 4 (CC4). The status signals will include the On status and the Failure alarm for the motor.
6. System will continuously monitor the air compressor discharge pressure (BSAC-7325). The pressure signal will be transmitted to Cake Pump Control Panel (BSPCP-7020) and Communication Cabinet 4 (CC4). A high alarm signal will be sent to Cake Pump Control Panel (BSPCP-7020) and Communication Cabinet 4 (CC4). The set-point for the alarm will be adjustable. The range will be between 0 to 250 psi. Initial set-point for the alarm will be 200 psi.

J. Cake Pump Piping Control Valves (BSKV-7151A2, BSKV-7152A2, BSKV-7251A2 & BSKV-7252A2)

1. Four motor operated knife gate valves are provided in the cake pump discharge lines to control where the cake is pumped to. A Local-Remote mode selector will be provided for each valve. In Local the valves will be controlled by Open-Close pushbuttons at the units. In Remote each valve will be controlled at Cake Pump Control Panel (BSPCP-7020), Dryer Control Panel (BSDCP-7030) and Communication Cabinet No. 4 (CC4). Each valve will have Open-Closed limit switches. The valve position will be indicated on the Cake Pump Control Panel (BSPCP-7020), Dryer Control Panel (BSDCP7030) and Communication Cabinet 4 (CC4).
2. The system will be provided by the Contractor and coordinated with the wet cake system supplier.
3. When either of the Cake Pumps (BSP-7130 & BSP-7230) start one of its respective Cake Pump Piping Control Valves must be open. If there is no open valve, an alarm status will be activated at the Cake Pump Control Panel (BSPCP-7020), Dryer Control Panel (BSDCP-7030) and Communication Cabinet 4 (CC4).

K. Cake Pump Pit Float Switch (BSPP-7330)

1. A liquid level float is installed in the cake pump pit to alarm if any water is accumulating in the pit. The system will transmit the signals to local indicators and to Cake Pump Control Panel (BSPCP-7020) and

Communication Cabinet No. 4 (CC4). The range will be between 0 to 5 inches. The float elevation is adjustable and initially set at 2 inches.

L. Dryer (BSD-7400)
1. The dryer system consists of all the components supplied by the Contractor and Therma-Flite including all ancillary components. It includes the dryer (BSD-7400), dryer drives (BSD-7401 & BSD-7402), thermal fluid heater (BSD-7440), cooling conveyor (BSD-7410), condenser/scrubber (BSD-7430), nitrogen gas purging systems (BSN-7470 & BSN-7451), odor treatment unit (BSOC-7700), junction box panel (BSD-7405) and junction box power panel (BSD-7406).
2. A pressure regulating valve (BSDPRV1-7417) is provided in the spray water piping to maintain a pre-set pressure to the dryer. The pressure will be set at 45 psig.
3. A solenoid valve (BSDSV1-7409A2) is provided to open the water supply line to the dryer spray system.
4. The dryer system is controlled from the Dryer Control Panel (BSDCP-7030).
5. Status signals from the dryer are transmitted through the Junction Box Panel (BSD-7405) and then to the Dryer Control Panel (BSDCP-7030) and Communication Cabinet 4 (CC4). The status signals will include the On status and the Failure alarm for all the equipment.
6. Power to the dryer drives (BSD-7401 and BSD-7402) and the cooling conveyor (BSD-7410) is controlled through the Junction Box Power Panel (BSD-7406) and then to the Dryer Control Panel (BSDCP-7030).

M. Cooling Conveyor (BSD-7410)
1. The cooling conveyor moves the biosolids from the dryer to the Biosolids Transfer Blower. Plant water is used by the cooling conveyor to lower the temperature of the discharged biosolids.
2. A solenoid valve (BSDSV1-7411) is provided to open when the cooling conveyor is in operation. The solenoid valve will receive a signal from the Dryer Control Panel (BSDCP7030) when the conveyor is to start and plant water will be fed to the conveyor.
3. A pressure regulating valve (BSDPRV1-7415) is provided in the spray water piping to maintain a pre-set pressure to the dryer. The pressure will be set at 45 psig.
4. Temperature Sensor (BSD-7419) measures the discharge water temperature at a preset high temperature and an alarm will sound.
5. The system will transmit the equipment status signals to Dryer Control Panel (BSDCP-7030) and Communication Cabinet 4 (CC4).

N. Dryer Scrubber (BSD-7430)
1. The water vapor and other off-gases removed from the sludge cake are vented through the condenser/scrubber system. The purpose of the scrubber is to reduce the temperature of the water discharged back to the plant headworks.

2. A motor operated valve (BSDBF1-7431A2) is provided to open when the scrubber is in operation. The valve will receive a signal from the Dryer Control Panel (BSDCP-7030) when the scrubber is to start and plant water will be fed to the scrubber. In order to prevent surges of water pressure to the scrubber during start-up and shut-down (water hammer) the motor operator will open and close the valve slowly over an adjustable timed period (0 – 20 seconds).
3. A pressure regulating valve (BSDPRV1-7437) is provided in the water piping to maintain a pre-set pressure to the scrubber. The pressure will be initially set at 45 psig.
4. A relief valve (BSRV1-7740) is provided on the exhaust line of the scrubber. The relief valve relieves any overpressures that may develop in the exhaust piping from the scrubber.
5. A flow meter (BSD-7435) is installed in the plant water line to monitor the flow rate to the scrubber (0 – 450 gpm).
6. A temperature sensor (BSD-7436) is installed in the discharge from the scrubber to monitor the water temperature discharging to the drain (0 – 150^{o}F). A high alarm signal will be sent to the Dryer Control Panel (BSDCP-7030) for water temperatures above 130^{o}F.
7. At start-up the valve will open to maintain an adjustable flow rate through the scrubber. As the temperature increases or decreases in the discharge water, the valve will be throttled to maintain the pre-set discharge temperature.
8. The system will transmit the equipment status signals to Dryer Control Panel (BSDCP7030) and Communication Cabinet 4 (CC4).

O. <u>Dryer Nitrogen Purge System (BSDN-7470)</u>
1. A nitrogen purge of the dryer is required during the start-up and shut-down sequences of the dryer. Nitrogen gas is fed to the dryer through the nitrogen gas system (BSN-7460). The system is controlled by the Silo Control Panel (BSSCP-7040).
2. If the temperature in the dryer increases to a pre-set point, an emergency nitrogen purge can be initiated by the dryer control system (BSDCP-7030).
3. The nitrogen gas feed to the dryer is controlled by a solenoid valve (BSDSV1-7455A2). Open-Close selector switches are provided at the Dryer Control Panel (BSDCP-7030).
4. The gas flow rate is adjusted at the rotometer (BSN-7453) from 0 – 1800 cfh.
5. A pressure regulating valve is provided in the nitrogen gas feed to the dryer (BSNPRV1-7458).
6. The system will transmit the equipment status signals to Dryer Control Panel (BSDCP-7030), Silo Control Panel (BSSCP-7040) and Communication Cabinet 4 (CC4).

P. <u>Thermal Fluid Heating System (BSD-7440)</u>
1. The thermal fluid heating system provides the heating oil to the dryer. The system consists of the thermal heater (BSD-7440), combustion fan (BSD-7443), heat exchanger (BSD-7444), circulating pump (BSD-7441), expansion

tank (BSD-7445), catchment tank (BSD-7442), natural gas flow meter (BSD-7449), and thermal fluid nitrogen blanket system (BSDN-7451).

2. The Thermal Fluid Heater Panel (BSD-7448) is provided with the thermal fluid heater to control the Oil Circulating Pump (BSD-7441) and the combustion fan (BSD-7443).
3. A flow meter shall be supplied for the natural gas (BSNG-7449) and measure the flow of natural gas to the thermal fluid heater. Pressure will also be monitored on the natural gas line (BSNG-7480).
4. A catchment tank (BSD-7442) shall be supplied by the Contractor for draining the expansion tank and vent. When high pressures occur in the expansion tank (BSD-7445), a signal will be sent to the Dryer Control Panel (BSDCP-7030) and fluid will fill the catchment tank.
5. Status signals from the thermal fluid heater panel are transmitted to the Dryer Control Panel (BSDCP-7030) and Communication Cabinet 4 (CC4). The status signals will include the On status and the Failure alarm for the system.

Q. Thermal Fluid Nitrogen Blanket System (BSDN-7451)

1. This system is used to feed nitrogen gas to the thermal fluid heating system. Nitrogen gas is fed to the expansion tank through the nitrogen gas system (BSN-7460). The system is controlled by the Silo Control Panel (BSSCP-7040).
2. The nitrogen gas feed to the expansion tank is by a solenoid valve (BSDSV1-7456A2). Open-Close-Auto selector switches are provided at the Dryer Control Panel (BSDCP-7030).
3. A pressure regulating valve is provided in the nitrogen gas feed to the expansion tank (BSNPRV1-7459).
4. The system will transmit the equipment status signals to Dryer Control Panel (BSDCP-7030), Silo Control Panel (BSSCP-7040) and Communication Cabinet 4 (CC4).

R. Odor Treatment Unit (BSOC-7700)

1. A biological odor treatment unit will be provided to treat the odors from the wet cake hoppers and the dryer. The unit will be provided by the dryer equipment supplier.
2. The off gases from the scrubber pass through the condenser and are transferred to the odor treatment unit. Odorous air from the wet cake hoppers will be collected and transferred to the biological treatment process. In normal operation the unit will operate continuously.
3. A motor operated valve (BSOC-7710) is provided to open the supply water to the odor treatment vessel sump.
4. The valve will receive a signal from the Odor Treatment Control Panel (BSOC-7715) when the sump level is low and plant water will be fed to the treatment unit.
5. A recirculation pump (BSOC-7720) pumps water from the sump to the irrigation supply piping.
6. An exhaust fan (BSOC-7730) pulls the air through the odor treatment vessel.

7. The system will transmit the equipment status signals to Dryer Control Panel (BSDCP-7030) and Communication Cabinet 4 (CC4). The status signals will include the On status and the Failure alarm for the system.

S. Biosolids Surge Bin (BSTB-7412)
1. The biosolids from the cooling conveyor will discharge into a Surge Bin. The system will be provided by the Silo equipment supplier.
2. A Rotary Valve (BSRV-7416), or pneumatic educator, shall be provided after the surge bin to feed the biosolids into the transfer piping to the silos. The valve will have a Hand-Off-Auto selector at the Motor Control Center Panel. In Hand it will run continuously. In the Auto position it will be controlled by the Dryer Control Panel (BSDCP-7030). When the blower is to operate the rotary valve will start.
3. The system will transmit the signals to Motor Control Center Panel (MCC-4), Dryer Control Panel (BSDCP-7030) and Communication Cabinet 4 (CC4).

T. Biosolids Transfer Blowers (BSTB-7420 & BSTB-7421)
1. This system consists of a transfer blower system to transfer the biosolids to the silos; there are two silos. The biosolids from the rotary valve (or pneumatic educator) are transferred through a pipeline to the silos with the aid of the transfer blowers. A three-way valve (BSS-7505A3) is located on the top of the silos to set which silo will receive the product.
2. The three-way valve (BSS-7505A3) is a pneumatically operated valve. A Silo No. 1-Silo No. 2 selector switch is located on the Silo Control Panel (BSSCP-7040) to set which silo will receive the biosolids.
3. The blower are will be controlled by Hand-Off-Auto selector switches located at the Motor Control Center Panel (MCC-4). In Hand they will run continuously. In the Auto position they will be controlled by the Silo Control Panel (BSSCP-7040). One blower will start and operate during the drying cycle. When the drying cycle is shutdown, that blower will stop and the blowers will alternate.
4. The system will transmit the equipment status signals to Silo Control Panel (BSSCP-7040), Dryer Control Panel (BSDCP-7030) and Communication Cabinet 4 (CC4).

U. Transfer Blower Discharge Pressure (BSTB-7422)
1. System will continuously monitor the blower discharge to the silos. The system will be provided by the Biosolids Silo equipment supplier.
2. The pressure signal will be transmitted to Dryer Control Panel (BSDCP-7030) and Communication Cabinet 4 (CC4). A high alarm signal will be sent to Silo Control Panel (BSSCP-7040), Dryer Control Panel (BSDCP-7030) and Communication Cabinet 4 (CC4). The set-point for the alarm will be adjustable. The range will be between 0 to 20 psi. Initial set-point for the alarm will be 15 psi.

V. Silos (BSS-7500 & BSS-7600)
   1. There are two silos provided to store the biosolids prior to off-site disposal. The silo supplier will provide the Silo Control Panel (BSSCP-7040).
   2. The silo control panel will monitor silo sensors; load cells (BSS-7510 & BSS-7610), temperature (BSS-7520 & BSS-7620), level (BSS-7530 & BSS-7630), carbon monoxide (BSS-7540 & BSS-7640) and oxygen (BSS-7550 & BSS-7650). It will also control the Silos Truck Loading (BSS-7880 & BSS-7980), the Mineral Oil Pump (BSMO-7681), the Silo Vibrators (BSS-7560A3 & BSS-7660A3), pneumatic air compressor (BSS-7570), and Nitrogen Gas Feed system to the silos (BSN-7460).
   3. The system will transmit the equipment status signals to Silo Control Panel (BSDCP-7030), Dryer Control Panel (BSDCP-7030) and Communication Cabinet 4 (CC4).

W. Silo's Bag Houses (BSS-7501 & BSS-7601)
   1. There are two bag houses located on top of the silos to remove the dust in the dried biosolids as they discharge to the silos. An exhaust fan is located at each of the bag houses to exhaust the air through the filter material.
   2. Each fan will have a Hand-Off-Auto selector switch at the Silo Control Panel (BSSCP-7040). In Hand it will run continuously and in Auto it will run when the transfer blower is operating.
   3. Compressed air from the pneumatic air compressor (BSS-7570) supplies air to the actuators at bag house filters.
   4. Solenoid valves (BSSV1-7502A3 & BSSV1-7602A3) are provided for each bag house. The solenoid valves will be controlled by Open-Close pushbuttons at the Silo Control Panel (BSSCP-7040).
   5. There will be a pressure differential sensor at each bag house to monitor the pressure drop across the filters. If the differential pressure reaches a pre-set amount, an air burst from the silo air system will shake the filters to dislodge the dust collected. The differential pressure sensor will be provided by the silo equipment supplier.
   6. The system will transmit the status signals to Silo Control Panel (BSSCP-7040) and Communication Cabinet 4 (CC4). The status signals will include the On status and the Failure alarm for the motor.

X. Silos Feed Control Valve (BSS-7505A3)
   1. A pneumatically operated 3-way valve is provided in the biosolids transfer piping to the silos. The system will be provided by the Biosolids Silo equipment supplier.
   2. The valve will have a Silo No. 1 and Silo No. 2 selector switch at the Silo Control Panel (BSSCP-7040).
   3. The system will transmit the status signals to Silo Control Panel (BSSCP-7040) and Communication Cabinet 4 (CC4).

Y. Silos Load Cells (BSS-7510 & BSS-7610)
1. System will consist of load cells mounted under each support of the Silos to continuously monitor the weight of the biosolids discharged into the trucks. There will be four load cells per silo. The system will be provided by the silo supplier.
2. The load cells will be zeroed out at the tare weight of the silos, bag houses, etc. The totalized weight of the load cells at each silo as biosolids are added into the silo will be recorded as the silo weight.
3. The system will transmit the signals to Silo Control Panel (BSSCP-7040) and Communication Cabinet 4 (CC4). A high alarm signal will be sent to the Silo Control Panel (BSSCP-7040) and Communication Cabinet No. 4 (CC4).
4. The range will be between 0 to 125 tons.

Z. Silo Temperature Sensors (BSS-7520 & BSS-7620)
1. System consists of temperature sensors in the silos to continuously monitor the temperature inside the silos. There will be 1 “rope” type sensor per silo. The system will be provided by the silo supplier.
2. The system will transmit the signals to the Silo Control Panel (BSSCP-7040) and Communication Cabinet 4 (CC4). A high alarm signal will be sent to the Silo Control Panel (BSSCP-7040) and Communication Cabinet No. 4 (CC4).
3. The set-points for the alarms will be adjustable. The temperature range will be between 50º F to 160º F. Initial set-point for the alarm will be 120º F.

AA. Silo Level Sensors (BSS-7530 & BSS-7630)
1. System will continuously monitor the biosolids level in the silos (one “paddle-wheel” type sensor per silo). The system will be provided by the silo supplier.
2. The system will transmit the signals to the Silo Control Panel (BSSCP-7040) and Communication Cabinet 4 (CC4).
3. A high alarm signal will be sent to Silo Control Panel (BSSCP-7040) and Communication Cabinet 4 (CC4). The set-point for the alarm will be adjustable. The range will be 0 ft to 40 ft.

BB. Silo Carbon Monoxide Sensor (BSS-7540 & BSS-7640)
1. System will continuously monitor the carbon monoxide concentration in the silos (one sensor per silo). The system will be provided by the Contractor.
2. The system will transmit the signals to the Silo Control Panel (BSSCP-7040) and Communication Cabinet 4 (CC4). A high alarm signal will be sent to Silo Control Panel (BSSCP-7040) and Communication Cabinet No. 4 (CC4). The set-point for the alarm will be adjustable. The range will be between concentration 0 mg/L to 100 mg/L.

CC. Silo Oxygen Sensor (BSS-7550 & BSS-7650)
1. System will continuously monitor the oxygen concentration in the silos (one sensor per silo). The system will be provided by the Contractor.

2. The system will transmit the signals to the Silo Control Panel (BSSCP-7040) and Communication Cabinet 4 (CC4). A low oxygen alarm signal will be sent to Silo Control Panel (BSSCP-7040) and Communication Cabinet 4 (CC4). The set-point for the alarm will be adjustable. The range will be concentration 0 % O_2 to 21 % O_2.

DD. Silo Air Compressor (BSS-7570)

1. An air compressor is provided at the silos to operate the pneumatic valves, bag houses, and vibrators. The air compressor will be provided by the silo equipment supplier and will be located outside near the silos.
2. A Hand-Off-Auto selector switch is provided at the Silo Control Panel (BSSCP-7040) for the compressor.
3. The system will transmit the signals to the Silo Control Panel (BSSCP-7040), to Communication Cabinet No. 4 (CC4).

EE. Silo Vibrator (BSS-7560, BSS-7561, BSS-7660 & BSS-7661)

1. There are two pneumatic vibrators per silo mounted on the cone section of the silos. The vibrators can be used when loading trucks to ensure the biosolids material is feeding consistently into the truck loading mechanism.
2. The vibrators are controlled by Hand-Off-Auto selector switches on the Silo Control Panel (BSSCP-7040). In Hand they run continuously. In Auto they will run when the truck are being loaded.
3. Compressed air from the pneumatic air compressor (BSS-7570) supplies air to the actuators at each vibrator. The air supply to each vibrator is controlled by solenoid valves on the air line (BSSV1-7562A2, BSSV1-7563A2, BSSV1-7656A2 and BSSV1-7663A2).
4. The system will transmit the signals to the Silo Control Panel (BSSCP-7040), to Communication Cabinet No. 4 (CC4).

FF. Nitrogen Storage Tank (BSN-7460)

1. A 1500 gallon nitrogen storage tank is provided by the Contractor to store the nitrogen used at the dryer and silos.
2. There is a level sensor (BSN-7452) and pressure sensor (BSN-7454) provided at the tank by the nitrogen gas storage tank supplier. The level and pressure are transmitted to the Silo Control Panel (BSSCP-7040) and Communication Cabinet 4 (CC4).

GG. Silo Nitrogen Blanket System (BSNSV1-7590A2 & BSNSV1-7690A2)

1. This system is used to feed nitrogen gas to the silos through solenoid valves if the temperature or carbon monoxide in the silo becomes excessive. The temperature in each silo is monitored (BSS-7520 & BSS-7620) and the carbon monoxide is monitored (BSS-7540 & BSS-7640). At the high temperature or high carbon monoxide levels an alarm status will be activated at the Silo Control Panel (BSSCP-7040) and Communication Cabinet 4 (CC4).

2. Solenoid valves are provided in the nitrogen piping to each silo to open to feed nitrogen into the cone section of the silo. There are two (2) application points per silo spaced at 180 degrees apart. The solenoid valves will be controlled by Open-Close pushbuttons at the Silo Control Panel (BSSCP-7040).
3. A pressure regulating valve is provided in the nitrogen gas feed to the silos (BSNPRV1-7457).
4. The system will transmit the equipment status signals to Silo Control Panel (BSSCP-7040) and Communication Cabinet 4 (CC4).

HH. Mineral Oil Feed System (BSMO-7680)

1. This system is provided by the silo system supplier to feed mineral oil to the biosolids discharged to the trucks to reduce dust. The system consists of a heated storage tank (BSMO-7680), metering pump (BSMO-7681) and an atomizer (BSMO-7884 & BSMO-7984) in the biosolids Truck Loading system.
2. The metering pump will be controlled by a Hand-Off-Auto switch at the Silo Control Panel (BSSCP-7040). In Hand it runs continuously. In Auto it starts and stops when a truck is being loaded.
3. There are two motor operated valves (BSMOPV-7685 & BSMOPV-7686) in the mineral oil feed lines from the metering pump to the silos. The respective valve will open when a truck is being loaded from the silos. The valves will remain closed if the metering pump is Off.
4. The system will include an oil temperature sensor (BSMO-7683) in the tank and a liquid level sensor (BSMO-7682). The temperature and liquid level and equipment status is transmitted to Silo Control Panel (BSSCP-7040) and Communication Cabinet No. 4 (CC4). An alarm will be provided for low and high temperature. An alarm is provided for low liquid level. The set-points for the alarms will be adjustable. The temperature range will be between 50º F to 140º F. Initial set-point for the alarm will be 120º F. The liquid level range will be 0 ft to 12 ft. Initial set-point for the low level alarm will be 3 ft.

II. Silo Truck Loading (BSS-7880 & BSS-7980)

1. This system consists of the truck loading system at the silos. There are two knife gates connected in series under each silo. A manual knife gate sits on top of a pneumatically operated knife gate (BSSKV-7882A3 & BSSKV-7982A3). A motorized load out spout (BSS-7883 & BSS-7983) is provided under the knife gates. At the end of the load out spout an atomizing ring (BSMO-7884 & BSMO-7984) is provided for the mineral oil addition.
2. The two pneumatically operated gates are controlled by an Open-Close-Auto selector switch at the Silo Control Panel (BSSCP-7040). The discharge load out spout is operated with a Lower-Raise-Auto selector switch at the Silo Control Panel (BSSCP-7040). The mineral oil atomizing ring will receive the oil from the metering pump and solenoid valve described in System HH.
3. The truck loading sequence will be initiated by setting the weight of material to be discharged at the Silo Control Panel (BSSCP-7040). Truck Load Start-Stop pushbuttons are located on the Silo Control Panel (BSSCP-7040).

4. The discharge load out spout has a “Tilt” switch located at the discharge opening of the chute. When the Start pushbutton is pressed the load out spout will lower into the truck bed. When the chute and Tilt switch contact the floor the load out spout will stop lowering and raise a pre-set amount (6 inches to 18 inches) and the discharge gate will open. The material will discharge into the truck until the Tilt switch is tripped. The valve will close and the chute will raise the pre-set increment and the gate will open and the operation will repeat itself. When the load out spout reaches a pre-set high level an Alarm signal will be sent to Silo Control Panel (BSSCP-7040). If the total pounds of material have not been received in the truck, it will have to be pulled forward a few feet and the filling operation repeated.
5. When the weight discharged is within a percentage of the pre-set amount (75% - 100%), the gate will close and the mineral oil metering pump will stop. To continue feeding the remaining amount, press the Start pushbutton again.
6. The system will transmit the signals to the Silo Control Panel (BSSCP-7040) and to Communication Cabinet No. 4 (CC4).

The "PLC Input/Output List" forms a part of the Construction Documents and is attached.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PLC Input/Output List

Tag No.	Function	Description \ Location	DI	DO	AI	AO	Ethernet	P&ID No.	Notes
BSCHCP7010 - Hopper Package Panel									
BSCH7110		**Wet Cake Hopper No. 1**						I7.1.0	
LE7101	Level	Hopper No. 1			1		Y	I7.1.0	Range 0 - 10 Ft
LE7101	Level Alarm	in PLC					Y		Set Point 8 ft
LE7102	Level	Hopper No. 1			1		Y	I7.1.0	Range 0 - 10 Ft
LE7102	Level Alarm	in PLC					Y		Set Point 8 ft
WE7104	Weight	Hopper No. 1			6		Y	I7.1.0	Range 0 - 120 Tons
WE7104	Weight Alarm	In PLC					Y		Set Point 50 tons
MS7146	Motion	Hopper No. 1	1				Y	I7.1.0	
MS7147	Motion	Hopper No. 1	1				Y	I7.1.0	
BSBC-7121	ON Status	Live Bottom Conveyor No. 1	1				Y	I7.1.0	
BSBC-7121	FAIL Status	Live Bottom Conveyor No. 1	1				Y	I7.1.0	
BSBC-7121	RUN Command	Live Bottom Conveyor No. 1		1			Y	I7.1.0	
BSBC-7121	Speed Command	Live Bottom Conveyor No. 1				1	Y	I7.1.0	
BSBC-7121	Speed Feedback	Live Bottom Conveyor No. 1			1		Y	I7.1.0	
BSBC-7122	ON Status	Live Bottom Conveyor No. 2	1				Y	I7.1.0	
BSBC-7122	FAIL Status	Live Bottom Conveyor No. 2	1				Y	I7.1.0	
BSBC-7122	RUN Command	Live Bottom Conveyor No. 2		1			Y	I7.1.0	
BSBC-7122	Speed Command	Live Bottom Conveyor No. 2				1	Y	I7.1.0	
BSBC-7122	Speed Feedback	Live Bottom Conveyor No. 2			1		Y	I7.1.0	
BSCH7210		**Wet Cake Hopper No. 2**						I7.1.0	
LE7201	Level	Hopper No. 2			1		Y	I7.1.0	Range 0 - 10 Ft
LE7201	Level Alarm	in PLC					Y		Set Point 8 ft
LE7202	Level	Hopper No. 2			1		Y	I7.1.0	Range 0 - 10 Ft
LE7202	Level Alarm	in PLC					Y		Set Point 8 ft
WE7204	Weight	Hopper No. 2			6		Y	I7.1.0	Range 0 - 120 Tons
WE7204	Weight Alarm	In PLC					Y		Set Point 50 tons
MS7161	Motion	Hopper No. 2	1				Y	I7.1.0	
MS7162	Motion	Hopper No. 2	1				Y	I7.1.0	
BSBC-7221	ON Status	Live Bottom Conveyor No. 1	1				Y	I7.1.0	
BSBC-7221	FAIL Status	Live Bottom Conveyor No. 1	1				Y	I7.1.0	
BSBC-7221	RUN Command	Live Bottom Conveyor No. 1		1			Y	I7.1.0	
BSBC-7221	Speed Command	Live Bottom Conveyor No. 1				1	Y	I7.1.0	

PLC Input/Output List

Tag No.	Function	Description \ Location	DI	DO	AI	AO	Ethernet	P&ID No.	Notes
BSBC-7221	Speed Feedback	Live Bottom Conveyor No. 1			1		Y	I7.1.0	
BSBC-7222	ON Status	Live Bottom Conveyor No. 2	1				Y	I7.1.0	
BSBC-7222	FAIL Status	Live Bottom Conveyor No. 2	1				Y	I7.1.0	
BSBC-7222	RUN Command	Live Bottom Conveyor No. 2		1			Y	I7.1.0	
BSBC-7222	Speed Command	Live Bottom Conveyor No. 2				1	Y	I7.1.0	
BSBC-7222	Speed Feedback	Live Bottom Conveyor No. 2			1		Y	I7.1.0	
BSPCP7020 - Cake Pump Package Panel									
WE7135	Weight	Cake Pump No. 1			1		Y	I7.1.0	
WE7135	Weight Alarm	In PLC					Y		
WE7235	Weight	Cake Pump No. 2			1		Y	I7.1.0	
WE7235	Weight Alarm	In PLC					Y		
PE7136	Pressure	Cake Pump No.1			1		Y	I7.1.0	Range 0 - 250 psi
PE7136	Pressure Alarm	In PLC					Y		Set Point 200 psi
PE7236	Pressure	Cake Pump No.2			1		Y	I7.1.0	Range 0 - 250 psi
PE7236	Pressure Alarm	In PLC					Y		Set Point 200 psi
BSP7130	On Status	Cake Pump No. 1	1				Y	I7.1.0	
BSP7130	Fail Alarm	Cake Pump No. 1	1				Y	I7.1.0	
BSP7130	Run Command	Cake Pump No. 1		1			Y	I7.1.0	
BSP7130	Speed Command	Cake Pump No. 1				1	Y	I7.1.0	
BSP7130	Speed Feedback	Cake Pump No. 1			1		Y	I7.1.0	
BSP7230	On Status	Cake Pump No. 2	1				Y	I7.1.0	
BSP7230	Fail Alarm	Cake Pump No. 2	1				Y	I7.1.0	
BSP7230	Run Command	Cake Pump No. 2		1			Y	I7.1.0	
BSP7230	Speed Command	Cake Pump No. 2				1	Y	I7.1.0	
BSP7230	Speed Feedback	Cake Pump No. 2			1		Y	I7.1.0	
LS7330	Level Alarm	Pump Pit Float Switch	1				Y		PIC Supplied Range 0 - 5 inches Set Point 2 inches
BSSR7310	On Status	Slip Ring Pump	1				Y	I7.1.0	
BSSR7310	Fail Alarm	Slip Ring Pump	1				Y	I7.1.0	
BSSR7310	Run Command	Slip Ring Pump		1			Y	I7.1.0	
BSSRSV-17141A2	Open/Close Command	Solenoid Valve Pump No. 1		2			Y	I7.1.0	
BSSRSV-17242A2	Open/Close Command	Solenoid Valve Pump No. 2		2			Y	I7.1.0	
BSAC7320	On Status	Air Compressor and Receiver	1				Y	I7.1.0	

PLC Input/Output List

Tag No.	Function	Description \ Location	DI	DO	AI	AO	Ethernet	P&ID No.	Notes
BSAC7320	Fail Alarm	Air Compressor and Receiver	1				Y	I7.1.0	
BSAC7320	Run Command	Air Compressor and Receiver		1			Y	I7.1.0	
BSACSV1-7321A2	Open/Close Command	Solenoid Valve to Pump No. 1 Discharge		2			Y	I7.1.0	
BSACSV1-7322A2	Open/Close Command	Solenoid Valve to Pump No. 2 Discharge		2			Y	I7.1.0	
PE7325	Pressure	Air Compressor and Receiver			1		Y	I7.1.0	Range 0 - 250 psi
PE7325	Pressure Alarm	In PLC					Y		Set Point 200 psi
BSKV7151A2	Fail Alarm	Cake Knife Gate	1				Y	I7.1.0	Pump No. 1 to Dryer
BSKV7151A2	Open/Close Command	Cake Knife Gate		2			Y	I7.1.0	Pump No. 1 to Dryer
BSKV7151A2	Open/Close Status	Cake Knife Gate	2				Y	I7.1.0	Pump No. 1 to Dryer
BSKV7251A2	Fail Alarm	Cake Knife Gate	1				Y	I7.1.0	Pump No. 2 to Dryer
BSKV7251A2	Open/Close Command	Cake Knife Gate		2			Y	I7.1.0	Pump No. 2 to Dryer
BSKV7251A2	Open/Close Status	Cake Knife Gate	2				Y	I7.1.0	Pump No. 2 to Dryer
BSKV7152A2	Fail Alarm	Cake Knife Gate	1				Y	I7.1.0	Pump No. 1 to Truck
BSKV7152A2	Open/Close Command	Cake Knife Gate		2			Y	I7.1.0	Pump No. 1 to Truck
BSKV7152A2	Open/Close Status	Cake Knife Gate	2				Y	I7.1.0	Pump No. 1 to Truck
BSKV7252A2	Fail Alarm	Cake Knife Gate	1				Y	I7.1.0	Pump No. 2 to Truck
BSKV7252A2	Open/Close Command	Cake Knife Gate		2			Y	I7.1.0	Pump No. 2 to Truck
BSKV7252A2	Open/Close Status	Cake Knife Gate	2				Y	I7.1.0	Pump No. 2 to Truck
BSDCP7030 - Dryer Package Control Panel									
BSD7401	On Status	Dryer Conveyor Drive	1				Y	I7.1.1	Terminates in Junction Box
BSD7401	Fail Alarm	Dryer Conveyor Drive	1				Y	I7.1.1	Terminates in Junction Box
BSD7401	Run Command	Dryer Conveyor Drive		1			Y	I7.1.1	Terminates in Junction Box
BSD7402	On Status	Dryer Conveyor Drive	1				Y	I7.1.1	Terminates in Junction Box
BSD7402	Fail Alarm	Dryer Conveyor Drive	1				Y	I7.1.1	Terminates in Junction Box
BSD7402	Run Command	Dryer Conveyor Drive		1			Y	I7.1.1	Terminates in Junction Box
BSD7410	On Status	Cooloing Conveyor	1				Y	I7.1.1	Terminates in Junction Box
BSD7410	Fail Alarm	Cooloing Conveyor	1				Y	I7.1.1	Terminates in Junction Box
BSD7410	Run Command	Cooloing Conveyor		1			Y	I7.1.1	Terminates in Junction Box
BSDSV1-7411	Fail Alarm	Solenoid Valve on Water to Cooling Conveyor	1				Y	I7.1.1	
BSDSV1-7411	Open/Close Command	Solenoid Valve on Water to Cooling Conveyor		2			Y	I7.1.1	
BSDSV1-7411	Open/Close Status	Solenoid Valve on Water to Cooling Conveyor	2				Y	I7.1.1	
TE7419	Water Temperature	Cooling Conveyor Drain			1		Y	I7.1.1	Terminates in Junction Box

PLC Input/Output List

Tag No.	Function	Description \ Location	DI	DO	AI	AO	Ethernet	P&ID No.	Notes
TE7419	Water Temperature	in PLC					Y	I7.1.1	Range 0 - 200° F
FE7435	Water Flow	Scrubber Water Supply			1		Y	I7.1.1	Terminates in Junction Box
FE7435	Water Flow	in PLC							Range 0 - 500 gpm
TE7436	Water Temperature	Scrubber Water Drain			1		Y	I7.1.1	Terminates in Junction Box
TE7436	Water Temperature	in PLC					Y	I7.1.1	Range 0 - 200° F
BSDBF1-7431A2	On Status	Water Supply to Scrubber	1				Y	I7.1.1	Terminates in Junction Box
BSDBF1-7431A2	Fail Alarm	Water Supply to Scrubber	1				Y	I7.1.1	Terminates in Junction Box
BSDBF1-7431A2	Valve modulation	Water Supply to Scrubber				1	Y	I7.1.1	Terminates in Junction Box
BSDSV1-7409A2	Fail Alarm	Solenoid Valve for Spray Water	1				Y	I7.1.1	
BSDSV1-7409A2	Open/Close Command	Solenoid Valve for Spray Water		2			Y	I7.1.1	
BSDSV1-7409A2	Open/Close Status	Solenoid Valve for Spray Water	2				Y	I7.1.1	
BSD-7441	On Status	Thermal Fluid Circulating Pump	1				Y	I7.1.1	From BSD-7448
BSD-7441	Fail Alarm	Thermal Fluid Circulating Pump	1				Y	I7.1.1	From BSD-7448
BSD7441	Run Command	Thermal Fluid Circulating Pump		1			Y	I7.1.1	Status to BSDCP7032
BSD-7443	On Status	Combustion Fan	1				Y	I7.1.1	From BSD-7448
BSD-7443	Fail Alarm	Combustion Fan	1				Y	I7.1.1	From BSD-7448
BSD7443	Run Command	Combustion Fan		1			Y	I7.1.1	Status to BSDCP7035
BSOCSV1-7710	Fail Alarm	Solenoid Valve Odor Treatment Unit Water	1				Y	I7.1.1	
BSOCSV1-7710	Open/Close Command	Solenoid Valve Odor Treatment Unit Water		2			Y	I7.1.1	Terminates in Junction Box
BSOCSV1-7710	Open/Close Status	Solenoid Valve Odor Treatment Unit Water	2				Y	I7.1.1	
BSOC-7720	On Status	Recirculationg Pump	1				Y	I7.1.1	From BSOC-7715
BSOC-7720	Fail Alarm	Recirculationg Pump	1				Y	I7.1.1	From BSOC-7715
BSOC7720	Run Command	Recirculationg Pump		1			Y	I7.1.1	Status to BSDCP7032
BSOC-7730	On Status	Exhaust Fan	1				Y	I7.1.1	From BSOC-7715
BSOC-7730	Fail Alarm	Exhaust Fan	1				Y	I7.1.1	From BSOC-7715
BSOC7730	Run Command	Exhaust Fan		1			Y	I7.1.1	Status to BSDCP7035
BSOC7700	On Status	Odor Treatment Unit	1				Y	I7.1.1	
BSOC7700	Fail Alarm	Odor Treatment Unit	1				Y	I7.1.1	
FE7449	Natural Gas Flow	Thermal Fluid Boiler			1		Y	I7.1.1	Range 0 - 15,000 cfh
FE7449	Natural Gas Flow	in PLC							
PE7480	Natural Gas Pressure	Thermal Fluid Boiler			1		Y	I7.1.1	Range 0 - 2.0 psi
PE7480	Natural Gas Pressure	in PLC							
BSD-7470	On Status	Nitrogen Purge System	1				Y	I7.1.1	
BSD-7470	Fail Alarm	Nitrogen Purge System	1				Y	I7.1.1	

PLC Input/Output List

Tag No.	Function	Description \ Location	DI	DO	AI	AO	Ethernet	P&ID No.	Notes
BSDSV1-7455A2	Open/Close Command	Nitrogen Purge Gas Supply		2			Y	I7.1.1	
BSDSV1-7455A2	Open/Close Status	Nitrogen Purge Gas Supply	2				Y	I7.1.1	
BSN-7451	On Status	Thermal Fluid Nitrogen Blanket System	1				Y	I7.1.1	
BSDSV1-7456A2	Open/Close Command	Thermal Fluid Nitrogen Gas Supply		2			Y	I7.1.1	
BSDSV1-7456A2	Open/Close Status	Thermal Fluid Nitrogen Gas Supply	2				Y	I7.1.1	
BSD7430	On Status	Dryer Scrubber	1				Y	I7.1.1	
BSD7430	Fail Alarm	Dryer Scrubber	1				Y	I7.1.1	
BSD7431A2	Open/Close Command	Scrubber Water Supply		2			Y	I7.1.1	
BSD7431A2	Open/Close Status	Scrubber Water Supply	2				Y	I7.1.1	
FE7435	Flow	Scrubber Water Meter			1		Y	I7.1.1	
TE7436	Temperature	Scrubber Water Temperature			1		Y	I7.1.1	
BSRF-7416	ON Status	Rotary Valve	1				Y	I7.1.2	
BSRF-7416	FAIL Status	Rotary Valve	1				Y	I7.1.2	
BSRF-7416	RUN Command	Rotary Valve		1			Y	I7.1.2	
PE7422	Pressure	Blower Discharge Pressure			1		Y	I7.1.2	Range 0 - 20 psi
PE7422	Pressure Alarm	In PLC					Y		Set Point 15 psi
BSSCP77040 - Silo Package Panel									
BSTB-7420	ON Status	Transfer Blower No. 1	1				Y	I7.1.2	
BSTB-7420	FAIL Status	Transfer Blower No. 1	1				Y	I7.1.2	
BSTB-7420	RUN Command	Transfer Blower No. 1		1			Y	I7.1.2	
BSTB-7421	ON Status	Transfer Blower No. 2	1				Y	I7.1.2	
BSTB-7421	FAIL Status	Transfer Blower No. 2	1				Y	I7.1.2	
BSTB-7421	RUN Command	Transfer Blower No. 2		1			Y	I7.1.2	
BSS-7505A3	Fail Alarm	3-Way Valve	1				Y	I7.1.2	Pneumatically Operated
BSS-7505A3	Silo No. 1/Silo No 2 Command	3-Way Valve		2			Y	I7.1.2	
BSS-7505A3	Silo No. 1/Silo No 2 Status	3-Way Valve	2				Y	I7.1.2	
BSS-7501	ON Status	Silo No. 1 Bag House Exhaust Fan	1				Y	I7.1.2	
BSS-7501	FAIL Status	Silo No. 1 Bag House Exhaust Fan	1				Y	I7.1.2	
BSS-7501	RUN Command	Silo No. 1 Bag House Exhaust Fan		1			Y	I7.1.2	
BSSV1-7502A2	Open/Close Command	Silo No. 1 Bag House Shaker		2			Y	I7.1.2	

PLC Input/Output List

Tag No.	Function	Description \ Location	DI	DO	AI	AO	Ethernet	P&ID No.	Notes
BSSV1-7502A2	Open/Close Status	Silo No. 1 Bag House Shaker	2				Y	I7.1.2	
BSS-7601	ON Status	Silo No. 2 Bag House Exhaust Fan	1				Y	I7.1.2	
BSS-7601	FAIL Status	Silo No. 2 Bag House Exhaust Fan	1				Y	I7.1.2	
BSS-7601	RUN Command	Silo No. 2 Bag House Exhaust Fan		1			Y	I7.1.2	
BSSV1-7602A2	Open/Close Command	Silo No. 2 Bag House Shaker		2			Y	I7.1.2	
BSSV1-7602A2	Open/Close Status	Silo No. 2 Bag House Shaker	2				Y	I7.1.2	
WE7510	Weight	Silo No. 1			4		Y	I7.1.2	Range 0 -125 tons
WE7510	Weigth Alarm	In PLC					Y		Set Point 90 tons
WE7610	Weight	Silo No. 2			4		Y	I7.1.2	Range 0 -125 tons
WE7610	Weigth Alarm	In PLC					Y		Set Point 90 tons
TE7520	Temperature	Silo No. 1			8		Y	I7.1.2	Range 0 - 160 ^{o}F
TE7520	Temperature Alarm	In PLC					Y		Set Point 100 ^{o}F
									Thermocouples
TE7620	Temperature	Silo No. 2			8		Y	I7.1.2	Range 0 - 160 ^{o}F
TE7620	Temperature Alarm	In PLC					Y		Set Point 100 ^{o}F
									Thermocouples
LE7530	Level	Silo No. 1			1		Y	I7.1.2	Range 0 - 40 ft
LE7530	Level Alarm	In PLC					Y		Set Point 30 ft
LE7630	Level	Silo No. 2			1		Y	I7.1.2	Range 0 - 40 ft
LE7630	Level Alarm	In PLC					Y		Set Point 30 ft
AE7540	Carbon Monoxide	Silo No. 1			1		Y	I7.1.2	Range 0 to 200 mg/L
AE7540	Carbon Monoxide Alarm	In PLC					Y		Set Point 25 mg/L
									PIC Supplied
AE7640	Carbon Monoxide	Silo No. 2			1		Y	I7.1.2	Range 0 to 200 mg/L
AE7640	Carbon Monoxide Alarm	In PLC					Y		Set Point 25 mg/L
									PIC Supplied
AE7550	Oxygen	Silo No. 1			1		Y	I7.1.2	Range 0 to 21%
AE7550	Oxygen Alarm	In PLC					Y		Set Point 5%
									PIC Supplied
AE7650	Oxygen	Silo No. 2			1		Y	I7.1.2	Range 0 to 21%
AE7650	Oxygen Alarm	In PLC					Y		Set Point 5%
									PIC Supplied
BSS-7560A3	FAIL Status	Vibrator Silo No. 1	1				Y	I7.1.2	Two vibrators per silo
BSS-7560A3	Open/Close Command	Vibrator Silo No. 1		1			Y	I7.1.2	
BSS-7560A3	Open/Close Status	Vibrator Silo No. 1	1				Y	I7.1.2	
BSSV1-7562A2	Open/Close Command	Solenoid Valve on Vibrator Silo No. 1		2			Y	I7.1.2	
BSSV1-7562A2	Open/Close Status	Solenoid Valve on Vibrator Silo No. 1	2				Y	I7.1.2	

PLC Input/Output List

Tag No.	Function	Description \ Location	DI	DO	AI	AO	Ethernet	P&ID No.	Notes
BSS-7561A3	FAIL Status	Vibrator Silo No. 1	1				Y	I7.1.2	
BSS-7561A3	Open/Close Command	Vibrator Silo No. 1		2			Y	I7.1.2	
BSS-7561A3	Open/Close Status	Vibrator Silo No. 1	2				Y	I7.1.2	
BSSV1-7563A2	Open/Close Command	Solenoid Valve on Vibrator Silo No. 1		2			Y	I7.1.2	
BSSV1-7563A2	Open/Close Status	Solenoid Valve on Vibrator Silo No. 1	2				Y	I7.1.2	
BSS-7660A3	FAIL Status	Vibrator Silo No. 2	1				Y	I7.1.2	Two vibrators per silo
BSS-7660A3	Open/Close Command	Vibrator Silo No. 2		2			Y	I7.1.2	
BSS-7660A3	Open/Close Status	Vibrator Silo No. 2	2				Y	I7.1.2	
BSSV1-7662A2	Open/Close Command	Solenoid Valve on Vibrator Silo No. 2		2			Y	I7.1.2	
BSSV1-7662A2	Open/Close Status	Solenoid Valve on Vibrator Silo No. 2	2				Y	I7.1.2	
BSS-7661A3	FAIL Status	Vibrator Silo No. 2	1				Y	I7.1.2	
BSS-7661A3	Open/Close Command	Vibrator Silo No. 2		2			Y	I7.1.2	
BSS-7661A3	Open/Close Status	Vibrator Silo No. 2	2				Y	I7.1.2	
BSSV1-7663A2	Open/Close Command	Solenoid Valve on Vibrator Silo No. 2		2			Y	I7.1.2	
BSSV1-7663A2	Open/Close Status	Solenoid Valve on Vibrator Silo No. 2	2				Y	I7.1.2	
BSMO7680		**Mineral Oil Tank System**						I7.1.2	
LE7682	Level	Mineral Oil Tank			1		Y	I7.1.2	Range 0 - 12 ft
LE7682	Level Alarm	In PLC					Y	I7.1.2	Set Point 3 ft
TE7683	Temperature	Mineral Oil Tank			1		Y	I7.1.2	Range 80 - 120 ^{o}F
TE7683	Temperature Alarm	In PLC					Y	I7.1.2	Set Point 120 ^{o}F
BSMO-7681	ON Status	Mineral Oil Metering Pump	1				Y	I7.1.2	
BSMO-7681	FAIL Status	Mineral Oil Metering Pump	1				Y	I7.1.2	
BSMO-7681	RUN Command	Mineral Oil Metering Pump		1			Y	I7.1.2	
BSMOPV-7685A2	Open/Close Command	Mineral Oil Solenoid Valve Silo No. 1		2			Y	I7.1.2	
BSMOPV-7685A2	Open/Close Status	Mineral Oil Solenoid Valve Silo No. 1	2				Y	I7.1.2	
BSMOPV-7686A2	Open/Close Command	Mineral Oil Solenoid Valve Silo No. 2		2			Y	I7.1.2	
BSMOPV-7686A2	Open/Close Status	Mineral Oil Solenoid Valve Silo No. 2	2				Y	I7.1.2	
BSNG7460		**Nitrogen Gas Storage Tank**						I7.1.2	
PE7454	Pressure	Nitrogen Storage Tank			1		Y	I7.1.2	Range 0 - 250 psi
PE7454	Pressure Alarm	In PLC					Y		Set Point 50 psi
LE7452	Level	Nitrogen Storage Tank			1		Y	I7.1.2	Range 0 - 16 ft
LE7452	Level Alarm	In PLC					Y		Set Point 3 ft

PLC Input/Output List

Tag No.	Function	Description \ Location	DI	DO	AI	AO	Ethernet	P&ID No.	Notes
BSNSV1-7590A2	Open/Close Command	Solenoid Valve Silo No. 1		1			Y	I7.1.2	
BSNSV1-7590A2	Open/Close Status	Solenoid Valve Silo No. 1	1				Y	I7.1.2	
BSNSV1-7690A2	Open/Close Command	Solenoid Valve Silo No. 2		1			Y	I7.1.2	
BSNSV1-7690A2	Open/Close Status	Solenoid Valve Silo No. 2	1				Y	I7.1.2	
BSS7580		**Silo No. 1 Truck Loading System**						I7.1.2	
BSKV-7882A3	Fail Alarm	Silo No. 1 Discharge Gate	1				Y	I7.1.2	
BSKV-7882A3	Open/Close Command	Silo No. 1 Discharge Gate		2			Y	I7.1.2	
BSKV-7882A3	Open/Close Status	Silo No. 1 Discharge Gate	2				Y	I7.1.2	
BSS-7883	Fail Alarm	Silo No. 1 Discharge Chute	1				Y	I7.1.2	
BSS-7883	Raise/Lower Command	Silo No. 1 Discharge Chute		2			Y	I7.1.2	
BSS-7883	Raise/Lower Status	Silo No. 1 Discharge Chute	2				Y	I7.1.2	
BSS7680		**Silo No. 2 Truck Loading System**						I7.1.2	
BSKV-7983A3	Fail Alarm	Silo No. 2 Discharge Gate	1				Y	I7.1.2	
BSKV-7983A3	Open/Close Command	Silo No. 2 Discharge Gate		2			Y	I7.1.2	
BSKV-7983A3	Open/Close Status	Silo No. 2 Discharge Gate	2				Y	I7.1.2	
BSS-7983	Fail Alarm	Silo No. 2 Discharge Chute	1				Y	I7.1.2	
BSS-7983	Raise/Lower Command	Silo No. 2 Discharge Chute		2			Y	I7.1.2	
BSS-7983	Raise/Lower Status	Silo No. 2 Discharge Chute	2				Y	I7.1.2	
BSS7670		**Silo Air Compressor**						I7.1.2	
BSS-7570	On Status	Pneumatic Air Compressor	1				Y	I7.1.2	
BSS-7570	Fail Alarm	Pneumatic Air Compressor	1				Y	I7.1.2	
BSS-7570	Run Command	Pneumatic Air Compressor		1			Y	I7.1.2	

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 REFERENCES

A. The following is a list of standards which may be referenced in this Section:
   1. Instrumentation, Systems, Automation Society (ISA): S50.1, Compatibility of Analog Signals for Electronic Process Instruments.
   2. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. AB 1, Molded Case Circuit Breakers and Molded Case Switches.
      c. ICS 2, Industrial Control Devices, Controllers and Assemblies.
   3. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
   4. Underwriters Laboratories Inc. (UL): 508A, Standards for Safety, Industrial Control Panels.

1.3 SYSTEM DESCRIPTION

A. Assemble panels and install instruments, plumbing, and wiring in equipment manufacturer's factories.

B. Test panels and panel assemblies for proper operation prior to shipment from equipment manufacturer's factory.

1.4 SUBMITTALS

A. Submittals:
   1. Bill of material, catalog information, descriptive literature, wiring diagrams, and Shop Drawings for components of control system.
   2. Catalog information on electrical devices furnished with system.
   3. Shop Drawings, catalog material, and dimensional layout drawings for control panels and enclosures.
   4. P&ID showing entire system including instruments and 1/0. Tag all components shown on the P&ID.
   5. Panel elementary diagrams of prewired panels. Include in diagrams control devices and auxiliary devices, for example, relays, alarms, fuses, lights, fans, and heaters.
   6. Plumbing diagrams of pre-plumbed panels and interconnecting plumbing diagrams.
   7. Interconnection wiring diagrams that include numbered terminal designations showing external interfaces.
   8. Test Plan: Submit test plan before scheduling a factory test.
   9. Software Emulation and Data Integration Development Plan for Ethernet Network connected PLCs: Submit plan for emulation of data exchange between package system and Plant SCADA system. Data exchange shall be emulated at the Factory Acceptance Test (FAT).

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Informational Submittals:
   1. Programmable Controller Submittals:
      a. Complete set of user manuals.
      b. Fully documented ladder logic listings.
      c. Function listing for function blocks not fully documented by ladder logic listings.
      d. Cross-reference listing.
   2. Application Software Submittals:
      a. Submit annotated data exchange tables that list all READ/WRITE bits and words with corresponding PLC addresses for approval. These tables must meet the plant computer system data exchange requirements.
      b. Submit examples of graphic displays developed for the local operator interface.
      c. Submit examples of ladder logic for key process sequences.
   3. Manufacturer's list of proposed spares, expendables, and test equipment.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Prior to shipment, include corrosive-inhibitive vapor capsules in shipping containers and related equipment as recommended by capsule manufacturer.

1.6 EXTRA MATERIALS

A. Spares, Expendables, and Test Equipment:
   1. Selector Switch, Pushbutton, and Indicating Light: 10 percent, one minimum, of each type used.
   2. Light Bulb: 20 percent, 2 minimum, of each type used.
   3. Fuse: 20 percent, 5 minimum, of each type used.
   4. Surge Suppressors: 20 percent, one minimum, of each type used.

PART 2 - PRODUCTS

2.1 SIGNAL CHARACTERISTICS

A. Analog Signals:
   1. 4 to 20 mA, in accordance with compatibility requirements of ISA S50.1.
   2. Unless otherwise specified or shown, use Type 2, two-wire circuits.
   3. Transmitters: Load resistance capability conforming to Class L.
   4. Fully isolate input and output signals of transmitters and receivers.

B. Pulse Frequency Signals: dc pulses whose repetition rate is linearly proportional to process variable over 10:1 range. Generate pulses by contact closures or solid-state switches.
   1. Power source: Less than 30V dc.

C. Discrete Signals:
   1. Two-state logic signals.
   2. Utilize 120V AC or 24V DC sources for control and alarm signals.
   3. Alarm signals shall be normally open, close to alarm isolated contacts rated for 5-ampere at 120V AC and 2-ampere at 30V DC.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2.2 CORROSION PROTECTION

A. Corrosion-Inhibiting Vapor Capsule Manufacturers:
   1. Northern Technologies International Corporation; Model Zerust VC.
   2. Hoffmann Engineering; Model A-HCI.
   3. Or approved equal

2.3 CONTROL PANEL

A. Panel Construction and Interior Wiring: In accordance with the National Electrical Code (NEC), UL 508, state and local codes, and applicable sections of NEMA, ANSI, and ICECA.

B. Conform to NEMA ratings as specified in individual equipment sections.

C. Minimum Metal Thickness: 14-gauge.

D. All panels shall be NEMA 250, Type 4X Panels: Type 316 stainless steel construction, unless otherwise specified.

E. Doors:
   1. Three-point latching mechanisms in accordance with NEMA 250 Type l and 12 panels with doors higher than 18 inches.
   2. For other doors, stainless steel quick release clamps or three-point latching mechanisms.

F. Cutouts shall be cut, punched, or drilled and finished smoothly with rounded edges.

G. Access: Front, suitable for installation with back and sides adjacent to or in contact with other surfaces, unless otherwise specified.

H. Temperature Control:
   1. Size panels to adequately dissipate heat generated by equipment mounted on or in the panel.
   2. Furnish cooling fans with air filters if required to dissipate heat.
   3. For panels outdoors or in unheated areas, furnish thermostatically controlled heaters to maintain temperature above 40 degrees F.

I. Heat Exchangers/Air Conditioning for NEMA 4X Outdoor Panels: For NEMA 4X panels mounted outdoors, evaluate heat generated inside the panel taking into account all components. Provide internal circulating fans, heat exchangers and/or air conditioning, to limit panel internal temperature to 90 degrees F with ambient temperatures of 120 degrees F. NEMA 4X rating shall not be compromised as a result of heat exchanging systems.

J. Push-to-Test Circuitry: For each push-to-test indicating light, provide a fused push-to-test circuit.

K. Lighting: Minimum of one hand switch controlled internal 100-watt fluorescent light for panels 12 cubic feet and larger.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

L. Minimum of one 120-volt GFCI duplex receptacle for panels 12 cubic feet and larger.

M. Finish:
1. Metallic External Surfaces (Excluding Aluminum and Stainless Steel): Manufacturer's standard gray unless otherwise specified.
2. Internal Surfaces: White enamel.
3. Provide manufacturer's electrostatically applied TGIC polyester powder coat white paint for all aluminum and stainless steel panels that will be mounted outdoors.

N. Panel Manufacturers:
1. Hoffman.
2. Rittal.
3. Saginaw.
4. Or approved equal.

O. Breather and Drains: Furnish with NEMA 250, Type 4 and 4X panels.
1. Manufacturer and Product: Cooper Crouse-Hinds; ECD Type 4X Drain and Breather; Drain Model ECDI-N4D, Breather Model ECDI-N4B, or approved equal.

2.4 CONTROL PANEL ELECTRICAL

A. UL Listing Mark for Enclosures: Mark stating "Listed Enclosed Industrial Control Panel" per UL 508A.

B. I&C and electrical components, terminals, wires, and enclosures UL recognized or UL listed.

C. Control Panels without Motor Starters or Drives:
1. Furnish main circuit breaker and a circuit breaker on each individual branch circuit distributed from power panel.
2. Locate to provide clear view of and access to breakers when door is open. Group on single subpanel. Provide typed directory.
3. Circuit Breakers:
   a. Coordinate for fault in branch circuit trips, branch breaker, and not main breaker.
   b. Branch Circuit Breakers: 15 amps at 250V ac.

D. Control Panels with Three-Phase Power Supplies, Motor Starters, Variable Frequency Drives (VFDs), and/or DC-SCR Drives:
1. Interlock main circuit breaker with panel door.
   a. Mount logic controls, branch circuit breakers, overload reset switches, and other control circuit devices.
   b. Mount operator controls and indications on front access door.
2. Circuit Breakers:
   a. In accordance with NEMA AB I.
   b. 22,000-ampere RMS symmetrical rating, minimum at 480 volts, unless otherwise specified.
   c. Breakers, except Motor Branch Breakers: Molded case thermal magnetic.
   d. 22,000-ampere RMS symmetrical rating, minimum at 480 volts, unless otherwise specified in package system equipment specification sections.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

e. Tripping: Indicate with operator handle position.

3. Magnetic Motor Starters:
   a. Full voltage, NEMA ICS 2, Class A, Size 0 minimum.
   b. Include three-pole bimetallic or eutectic alloy thermal overload relays sized for each motor.
   c. Manual reset type with reset button mounted on panel door.
4. Motor Control: 120V ac (except intrinsically safe circuits where applicable).
   a. Power Control Transformer:
      1) Sufficient capacity to serve connected load, including 200 VA for duplex outlet plus l00 VA (minimum).
      2) Limit voltage variation to 15 percent during contact pickup.
      3) Fuse one side of secondary winding and ground the other.
      4) Furnish primary winding fuses in ungrounded conductors.
5. DC-SCR Drives: As specified in individual process specifications.
6. Variable Frequency Drives: As specified in individual process specifications.
7. Power Monitoring Relay:
   a. Protect three-phase equipment from single phasing, phase imbalance, or phase reversal.
   b. Separate, isolated contact outputs to stop motors and activate alarm light during abnormal conditions.
   c. Transient Voltage Protection: 10,000 volts.
   d. Manufacturer and Product: Furnas; Class 47 or equal.
8. Power Distribution Blocks: Furnish to parallel feed tap on branch circuit protective devices. Do not "leap frog" power conductors.
9. Terminations for Power Conductors: Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

E. Wiring:
1. ac Circuits:
   a. Type: 600-volt, Type MTW stranded copper.
   b. Size: For current to be carried, but not less than 14 AWG.
2. Analog Signal Circuits:
   a. Type: 300-volt, Type 2 stranded copper, twisted shielded pairs.
   b. Size: 18 AWG, minimum.
3. Other dc Circuits.
   a. Type: 600-volt, Type MTW stranded copper.
   b. Size: 18 AWG, minimum.
4. Separate analog and other dc circuits at least 6 inches from any ac power and control wiring.
5. Enclose wiring in sheet metal raceways or plastic wiring ducts.
6. Wire Identification: Numbered and tagged at each termination.
   a. Wire Tags: Machine printed, heat shrink.

F. Wiring Interface:
1. For analog and discrete signal, terminate at numbered terminal blocks.
2. For special signals, terminate power (240 volts or greater) at manufacturer's standard connectors.
3. For panel, terminate at equipment on/with which it is mounted.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

G. Terminal Blocks:
   1. Quantity:
      a. For external connections.
      b. Wire spare or unused panel mounted elements to their panels' terminal blocks.
      c. Spare Terminals: 20 percent of connected terminals, but not less than 10.
   2. General: Group to keep 120V ac circuits separate from 24V dc circuits.
      a. Connection Type: Screw connection clamp.
      b. Compression Clamp:
         1) Hardened steel clamp with transversal grooves penetrating wire strands providing a vibration-proof connection.
         2) Guides strands of wire into terminal.
      c. Screws: Hardened steel, captive, and self-locking.
      d. Current Bar: Copper or treated brass.
      e. Insulation:
         1) Thermoplastic rated for minus 55 to plus 110 degrees C.
         2) Two funnel shaped inputs to facilitate wire entry.
      f. Mounting:
         1) Rail.
         2) Terminal block can be extracted from an assembly without displacing adjacent blocks.
         3) End Stops: One at each end of rail, minimum.
      g. Wire Preparation: Stripping only.
      h. Jumpers: Allow jumper installation without loss of space on terminal or rail.
      i. Marking System:
         1) Terminal number shown on both sides of terminal block.
         2) Allow use of preprinted and field marked tags.
         3) Terminal strip numbers shown on end stops.
         4) Mark terminal block and terminal strip numbers as shown.
   3. Terminal Block, 120-Volt Power:
      a. Rated Voltage: 600V ac.
      b. Rated Current: 30 amps.
      c. Wire Size: 22 through 10 AWG.
      d. Rated Wire Size: 10 AWG.
      e. Color: Gray body.
      f. Spacing: 0.25 inch, maximum.
   4. Terminal Block, Ground:
      a. Wire Size: 22 through 12 AWG.
      b. Rated Wire Size: 12 AWG.
      c. Color: Green and yellow body.
      d. Spacing: 0.25 inch, maximum.
      e. Grounding: Ground terminal blocks electrically grounded to mounting rail.
   5. Terminal Block, Blade Disconnect Switch:
      a. Use: Provide one for each discrete input and output field interface wire.
      b. Rated Voltage: 600V ac.
      c. Rated Current: 10 amps.
      d. Wire Size: 22 through 12 AWG.
      e. Rated Wire Size: 12 AWG.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

f. Color: Gray body, orange switch.
g. Spacing: 0.25 inch, maximum.

6. Terminal Block, Fused, 24V dc:
   a. Rated Voltage: 600V dc (provide for each discrete input).
   b. Rated Current: 6.3 amps.
   c. Wire Size: 22 through 12 AWG.
   d. Rated Wire Size: 12 AWG.
   e. Color: Gray body.
   f. Fuse: 5 by 20 GMA fuses.
   g. Fuse Marking: Fuse amperage rating shown on top of terminal block.
   h. Indication: LED diode 24V dc.
   i. Leakage Current: 5.2 mA, maximum.
   j. Spacing: 0.32 inch, maximum.
7. Terminal Block, Fused, 120V ac:
   a. Rated Voltage: 600V ac.
   b. Rated Current: 6.3 amps.
   c. Wire Size: 22 through 12 AWG
   d. Rated Wire Size: 12 AWG.
   e. Color: Gray body.
   f. Fuse: 5 by 20 GMA fuses.
   g. Fuse Marking: Fuse amperage rating shown on top of terminal block.
   h. Indication: Neon lamp 110V ac.
   i. Leakage Current: 1.8 mA, maximum.
   j. Spacing: 0.32 inch, maximum.

H. Grounding: Internal copper grounding bus for ground connections on panels, consoles, racks, and cabinets. Signal ground and electrical safety ground must be connected together to form a single point ground within the panel. All metallic panel enclosures shall be bonded to the ground bus.

I. Relays:
1. General:
   a. Relay Mounting: Plug-in type socket.
   b. Relay Enclosure: Provide dust cover.
   c. Socket Type: Screw terminal interface with wiring.
   d. Socket Mounting: Rail.
   e. Furnish hold down clips.
2. Signal Switching Relay (provide for each discrete input):
   a. Type: Dry circuit.
   b. Contact Arrangement: 2 Form C contacts.
   c. Contact Rating: 5 amps at 28V DC or 120V AC.
   d. Contact Material: Gold or silver.
   e. Coil Voltage: As noted or shown.
   f. Coil Power: 0.9 watt (DC), 1.2VA (AC).
   g. Expected Mechanical Life: 10,000,000 operations.
   h. Expected Electrical Life at Rated Load: 100,000 operations.
   i. Indication Type: Neon or LED indicator lamp.
   j. Seal Type: Hermetically sealed case.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

k. Manufacturer and Product:
   1) Potter and Brumfield; Series KH/KHA.
   2) Idec.
   3) Allen-Bradley.
   4) Or approved equal.

3. Control Circuit Switching Relay, Non-latching (provide for each discrete output):
   a. Type: Compact general purpose plug-in.
   b. Contact Arrangement: 3 Form C contacts.
   c. Contact Rating: l0A at 28V dc or 240V ac.
   d. Contact Material: Silver cadmium oxide alloy.
   e. Coil Voltage: As noted or shown.
   f. Coil Power: 1.8 watts (dc), 2.7VA (ac).
   g. Expected Mechanical Life: 10,000,000 operations.
   h. Expected Electrical Life at Rated Load: 100,000 operations.
   i. Indication Type: Neon or LED indicator lamp.
   j. Push-to-test button.
4. Control Circuit Switching Relay, Latching:
   a. Type: Dual coil mechanical latching relay.
   b. Contact Arrangement: 2 Form C contacts.
   c. Contact Rating: 10A at 28V dc or 120V ac.
   d. Contact Material: Silver cadmium oxide alloy.
   e. Coil Voltage: As noted or shown.
   f. Coil Power: 2.7 watts (dc), 5.3VA (ac).
   g. Expected Mechanical Life: 500,000 operations.
   h. Expected Electrical Life at Rated Load: 50,000 operations.
5. Control Circuit Switching Relay, Time Delay:
   a. Type: Adjustable time delay relay.
   b. Contact Arrangement: 2 Form C contacts.
   c. Contact Rating: 10A at 240V ac.
   d. Contact Material: Silver cadmium oxide alloy.
   e. Coil Voltage: As specified or shown.
   f. Operating Temperature: Minus 10 to 55 degrees C.
   g. Repeatability: Plus or minus 2 percent.
   h. Delay Time Range: Select range such that time delay setpoint falls between 20 to 80 percent or range.
   i. Time Delay Set Point: As specified or shown.
   j. Mode of Operation: As specified or shown.
   k. Adjustment Type: Integral potentiometer with knob external to dust cover.

J. Intrinsic Safety Barriers:
1. Provide as shown on Drawings and as required by NFPA 70 (National Electric Code) for hazardous locations as designated by the Engineer and NFPA 820.
2. Install in accordance with the National Electric Code.
3. Provide UL listed Intrinsically Safe Relays and Intrinsically Safe Barriers selected based on the entity parameters of the associated instrument or device.
4. Intrinsically Safe Relays: Monitor discrete signals that originate in hazardous area and are used in a safe area.
   a. Manufacturers:

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1) MTL.
2) Stahl.
3) Or approved equal.

5. Intrinsically Safe Barriers: Interface analog signals as they pass from hazardous area to safe area.
   a. Manufacturers:
      1) MTL.
      2) Stahl.
      3) Or approved equal.

K. Programmable Logic Controllers:
   1. General:
      a. Provide PLCs meeting the following minimum requirements unless otherwise noted in specific package specification sections.
      b. Function: Used for process monitoring and control by emulating functions of conventional panel mounted equipment such as relays, timers, counters, current switches, calculation modules, PID controllers, stepping switches, and drum programmers.
      c. Type: Microprocessor based device programmable using ladder logic.
      d. Parts: Central processing unit (CPU), power supply, local and remote input/output modules, local and remote base (chassis/rack) controllers, I/O bases (chassis/rack), data highway, and factory assembled interconnecting cables. Provide components required to make a complete and totally operational system.
   2. Environmental:
      a. Temperature: Operating range 32 to 140 degrees F (0 to60 degrees C); storage range minus 40 to 158 degrees F (0 to70 degrees C).
      b. Humidity: Operating range 5 to 95 percent non-condensing.
      c. Vibration:
         1) Sinusoidal: IEC 68-2-6, Test Fe; 0.15 mm peak-to-peak, 10-to 57-Hz; I g, 57-to 150-Hz.
         2) Random: IEC 68-2-34, Test Fdc; 0.4 g%/Hz, 80-to 350-Hz, and 3dB/octave rolloff, 80-to 20-Hz and 350-to 2-KHz at 10 min/axis.
      d. Noise: IEC 801, Part 3, Level 3 and Part 4, Level 3;MIL STD-461B.
      e. Isolation: User-side to PLC side 1,500V rms.
   3. Central Processing Unit (CPU):
      a. Type: Microprocessor, 16-bit minimum.
      b. Scan Time: Less than I ms/K words of relay ladder logic.
      c. PLC Communications:
         1) Minimum 1 serial and one Ethernet communication port for communication with Owner's SCADA System.
      d. Instruction Set:
         1) Timers and Counters: minimum 256, minimum timer resolution 0.1 seconds; minimum counter count range 0 to32,000.
         2) Math: Signed integer and floating-point math including add, subtract, multiply, divide, square root, and compare.
         3) Register Operations: Shift registers, bit shift, bit set, bit clear, data move and data format conversion.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

4) Process Loop Control: User configurable direct or reverse acting PID loop control computation with the capability of both AUTO and MANUAL modes of operation, remote access to controller tuning constants; minimum of 16 PID loops.
5) Real Time Clock: Date and time set and compare.

e. Diagnostics:
1) Indicators: Battery status, PLC status, PLC operation mode, remote FO communication status.
2) Status Word: With failure status for PLC battery, scan overrun, communications, 1/0, special functions.
3) Power Up: PLC checks status of PROMs upon power up; runs self-diagnostics on power-up; periodically runs self-diagnostics while in RUN mode, halts logic processor and sets outputs to configured state if fatal error is detected.
4) Diagnostic Tables: Tables, displayable by programming computer, that describe nature and location (address) existing faults and errors.

f. Agency Approvals and Standards:
1) UL listed.
2) CSA certified.
3) DIN Standard 41494.
4) IEC-65A/WG6 draft proposal.
5) Factory Mutual approved.

4. Random Access Memory (RAM):
a. Type: CMOS type.
b. Word Size: 16 bits, minimum.
c. Battery Backup: 1 month, minimum.
d. Memory Size: Sufficient to implement all applications software plus 50 percent spare.
e. Memory Size: 8 K words of ladder logic memory, 2 K words of variable memory, plus required overhead for standard functions.
f. Read only memory (ROM) for controller's operating system and diagnostics.
g. Compact flash for non-volatile program storage.

5. Power Supply: One unit for each input/output base assembly:
a. Voltage: 120/220 volts (user selectable), 60-Hz input; 85 to132 volts output.

6. Input/Output: Complete input/output system (each I/O block should be individually fused).
a. Discrete Input Modules:
1) Voltage: 120 volts, 60-Hz.
2) Operating Power: 2 watts.
3) Points per Module: 16 maximum.
4) LED status indicator for each point.
5) Isolation: Between input point and PLC, 1,500 volts rms

b. Discrete Output Modules:
1) Voltage: 120 volts, 60-Hz.
2) Operating Power: 2 watts.
3) Load Rating: 2 amps continuous.
4) Isolation: Between PLC and output point, 1,500 volts rms.
5) Points per Module: 16 maximum.
6) LED status indicator for each point.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

c. Analog Input/Output Modules:
   1) Voltage: 24 volts dc.
   2) Power: 3 watts.
   3) Differential Analog Points Per Module: 8 maximum.
   4) Isolated Analog Output Points Per Module: 8 maximum.
   5) Isolation: Between PLC and 1/0 point and between 1/0points, 1,500 volts rms.

d. Pulse Input Modules:
   1) Input Voltage: 5V or 12-24V (user selectable).
   2) Input Current: 7 mA at 5V; 7.0 to 1.5 mA at 12-24V.
   3) Points per Module: 4, maximum.
   4) Maximum Input Frequency: 100 KHz in counter mode.
   5) Maximum Count Value: 0-999,999 (programmable).

7. Identification: Nameplates installed above/below each PLC component (CPU, 1/0 rack, power supply).
8. The PLC System shall be as manufactured by the following manufacturer complete with compatible modules, racks, power supplies as required to meet the system requirements:
   a. Allen-Bradley; ControlLogix.
   b. Or prior approved equal.

L. Front-of-Panel Devices in Conjunction with NEMA 250, Type 1 and 12 Panels:
1. Potentiometer Units:
   a. Three-terminal, oiltight construction, resolution of 1 percent and linearity of plus or minus 5 percent.
   b. Single-hole, panel mounting accommodating panel thicknesses between 1/8 and 1/4 inch.
   c. Include legend plates with service markings.
   d. Manufacturers and Products:
      1) Allen-Bradley; Model 800T.
      2) Or approved equal.
2. Indicating Lights:
   a. Push-to-test type, LED, oiltight, industrial type with integral full voltage 24 V dc.
   b. Screwed on prismatic glass lenses in colors noted and factory engraved legend plates for service legend.
   c. Manufacturers and Products:
      1) Allen Bradley Model 800T.
      2) Or approved equal.
3. Pushbutton, Momentary:
   a. Heavy-duty, oiltight, industrial type with full guard and momentary contacts rated for 10 amperes continuous at 120V ac.
   b. Standard size legend plates with black field and white markings for service legend.
   c. Manufacturers and Products:
      1) Square D; Class 9001, Type K.
      2) Eaton/Cutler-Hammer; Type T.
      3) Or approved equal.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

4. Selector Switch:
    a. Heavy-duty, oiltight, industrial type with contacts rated for120V ac service at 10 amperes continuous.
    b. Standard size, black field, legend plates with white markings, for service legend.
    c. Operators: Black knob type.
    d. Single-hole mounting, accommodating panel thicknesses from1/16 inch to 1/4 inch.
    e. Manufacturers and Products for Units with up to Four Selection Positions:
        1) Eaton/Cutler-Hammer; Type T.
        2) Or approved equal.
    f. Manufacturers and Products for Units with up to 12 Selection Positions:
        1) Rundel-Idec; Standard Cam Switch.
        2) Electroswitch; 31.
        3) Or approved equal.

M. Front-of-Panel Devices Used in Conjunction with NEMA 250, Type 4XPanels:
1. Potentiometer, Watertight:
    a. Three-terminal, heavy-duty NEMA 250, Type 4X watertight construction, resolution of 1 percent and linearity of plus or minus 5 percent.
    b. Single-hole, panel mounting accommodating panel thicknesses between 1/8 and 1/4 inch.
    c. Include engraved legend plates with service markings.
    d. Manufacturer and Product: Allen-Bradley; Bulletin 800H or approved equal.
2. Indicating Lights, Watertight:
    a. Heavy-duty, push-to-test type, LED, NEMA 250, Type 4X watertight, industrial type for 24 V dc applications and corrosion-resistant service.
    b. Screwed on prismatic lenses and factory engraved legend plates for service legend.
    c. Manufacturers and Products:
        1) Square D; Type SK.
        2) Allen-Bradley; Type 800H.
        3) Or approved equal.
3. Pushbutton, Momentary, Watertight:
    a. Heavy-duty, NEMA 250, Type 4X watertight, industrial type with momentary contacts rated for 120V ac service at 10 amperes continuous and corrosion-resistant service.
    b. Standard size, black field, legend plates with white markings for service legend.
    c. Manufacturers and Products:
        1) Square D; Type SK.
        2) Allen-Bradley; Type 800H.
        3) Or approved equal.
4. Selector Switch, Watertight:
    a. Heavy-duty, NEMA 250, Type 4X watertight, industrial type with contacts rated for 120V ac service at 10 amperes continuous and corrosion-resistant service.
    b. Standard size, black field, legend plates with white markings, for service legend.
    c. Operators: Black knob type.
    d. Single-hole mounting, accommodating panel thicknesses from 1/16 to 1/4 inch.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

5. Manufacturer and Products:
    1) Square D; Class 9001, Type SK.
    2) Allen-Bradley; Type 800H.
    3) Or approved equal.

2.5 INSTRUMENT TAG NUMBERS

A. Tag all instruments and package system components to conform with Engineer's tag numbering convention. Where applicable, use Engineer-provided tag numbers as shown on Drawings.

2.6 NAMEPLATES, NAMETAGS, AND SERVICE LEGENDS

A. Nametags: Permanently mounted bearing entire ISA tag number.
1. Panel Mounted: Plastic, mounted to instrument behind panel face.
2. Field Mounted: Engraved Type 316 stainless steel, 22-gauge minimum thickness, attached with stainless steel.

B. Service Legends (Integrally Mounted with Instrument) and Nameplates:
1. Engraved, rigid, laminated plastic type with adhesive back. Furnish service legends and nameplates to adequately describe functions of panel face mounted instruments.
2. Color: White with black letters.
3. Letter Height: 3/16 inch.
4. For each panel, face mounted laminated nameplate inscribed with the panel name and tag number. Color shall be white with black letters1/2 inch high.

2.7 HARDWARE DOCUMENTATION FOR ETHERNET NETWORKCONNECTED PLC'S

A. Provide the following for all elements of the PLC:
1. Block Diagram: A diagram showing all major system components. Identify components by manufacturer and model number. Show interconnecting cables diagrammatically.
2. Bill-of-Materials: A list of all PLC components. Group components by type and include:
    a. Component manufacturer, model number, and part number.
    b. Component description.
    c. Quantity supplied.
    d. Reference to component catalog information.
3. Descriptive Information: Catalog information, descriptive literature, performance specifications, internal wiring diagrams, power and grounding requirements, power consumption, and heat dissipation of all elements of the PLC system. Clearly mark all options and features proposed for this Project.
4. Interconnecting Wiring Diagrams: Diagrams shall show all PLC elements, their interconnecting cables and wiring terminations, and all terminations to all interacting elements and subsystems. Terminations shall be numbered. Terminations for circuits extending outside PLC assemblies and/or leaving panels shall be labeled with circuit names corresponding to the Circuit and Raceway Schedule. The external circuit portion of this diagram shall be coordinated with the Electrical Subcontractor and shall bear his mark showing that this work has been done.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

5. Outline Drawings: Equipment envelope Drawings showing external dimensions, enclosure materials, conduit connections, and installation requirements.
6. Installation Details: Any modifications or further details as may be required to supplement the Purchase Order Documents and adequately define the installation of the PLC elements.
7. Input/Output List: For each I/O point, list point type, tag number of the source or final control element, equipment description, PLC number, PLC terminal identification, rack number, module slot number, and PLC address.

2.8 APPLICATION SOFTWARE FOR ETHERNET NETWORK CONNECTED PLC'S

A. PLC Application Software Development Methodology: The programmable controller system (PLC) is required to communicate over a fiber optic data link with HMI servers and other PLCs to be provided by others. It is extremely important that each PLC is programmed in a way that allows elegant data exchange between the HMI, other PLCs, and this PLC. Coordinate data communication with the HMI applications programmer.
   1. All control and monitoring features of the package system HMI shall be available over the Plant SCADA control system.
   2. PLC shall be programmed using ladder logic.
   3. Provide annotated data exchange look up tables and other information to allow the HMI applications programmer to implement efficient data exchange between HMI and PLC.

B. The data exchange table must be submitted for approval with the Emulation and Data Integration plan.

C. Software Design Submittal: This submittal shall be a detailed description on the application program. Submit this material during the program development stage. Provide ladder logic programs to implement all functional requirements specified in applicable process specifications. This submittal shall be reviewed by the Engineer prior to the submittal of the Preliminary Software Documentation.

D. Preliminary Software Documentation; Provide this submittal at least 4 weeks prior to the Factory Test. Here the term "preliminary" refers only to the timing of this submittal, not the level of detail to be provided. This submittal shall be a fully detailed version of all the material described hereinafter under Paragraph O&M Manual, Paragraph Software Documentation, except that the CD disc copies are not required at this time.

E. Provide format of reports to be generated by HMI using data received from the PLC. Provide any required calculation procedures.

2.9 EXCEPTIONS TO ETHERNET CONNECTION REQUIREMENTS FOR PLCS

A. For certain package systems that do not include a PLC or include a Micro PLC with no provision for Ethernet connection, a prior approval of the Owner is mandatory. Provide specific reasons explaining why the Ethernet connection cannot be provided. If such request is granted, then the Supplier shall include provision for hard wiring of analog and digital signals to the Owner's SCADA System.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2.10 ELECTRICAL SURGE AND TRANSIENT PROTECTION

A. General:
   1. Function: Protect elements of PICS against damage due to electrical transients induced in interconnecting lines by lightning and nearby electrical systems.
   2. Implementation: Provide, install, coordinate, and inspect grounding of surge suppressors at:
      a. Connection of ac power to PICS equipment including panels, console assemblies, and field mounted analog transmitters and receivers.
      b. At the field and panel, console, or assembly connection of signal circuits including analog and data lines.
   3. Construction: First-stage high energy metal oxide varistor and second-stage bipolar silicon avalanche device separated by series impedance. Includes grounding wire, stud, or terminal.
   4. Response: 5 nanoseconds maximum.
   5. Recovery: Automatic.
   6. Temperature Range: Minus 20 degrees C to plus 85 degrees C.

B. Suppressor Locations:
   1. At point of connection between each equipment item, including ac powered transmitters and its power supply conductors (direct wired equipment).
   2. On analog pairs at each end when the pair travels outside of building.
   3. In other locations where equipment sensitivity to surges and transients requires additional protection beyond that inherent to design of equipment.

C. Suppressors on 120V ac Power Supply Connections:
   1. Occurrences: Tested and rated for a minimum of 50 occurrences of IEEE 587 Category B test waveform.
   2. First-Stage Clamping Voltage: 350 volts or less.
   3. Second-Stage Clamping Voltage: 210 volts or less.
   4. Continuous Operation:
      a. Power supplies for one four-wire transmitter or receiver: 5 amps minimum at 130V ac.
      b. All other applications: 30 amps minimum at 130V ac.

D. Power Supply Suppressor Assemblies:
   1. Suitable for connection to 120-volt, single-phase power supplies under15 amps EDCO "HSP SERIES" or approved equal.
   2. Suitable for connection to 120-volt, single-phase power supplies over15 amps EDCO "IL SERIES" or approved equal.
   3. Suitable for connection to 480-volt, three-phase power supplies; Square D J9200-9A or EDCO "IL SERIES" or approved equal.

E. Suppressors on Analog Signal Lines:
   1. Test Waveform: Linear 8 microsecond rise in current form 0 amp to a peak current value followed by an exponential decay of current reaching one-half the peak value in 20 microseconds.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2. Surge Rating: Tested and rated for 50 occurrences of 2,000-amp peak test waveform.
   a. dc Clamping Voltage: 20 to 40 percent above operating voltage for circuit.
   b. dc Clamping Voltage Tolerance: Less than plus or minus10 percent.
   c. Maximum Loop Resistance: 18 ohms per conductor.

F. Physical Characteristics:
   1. Mounted in Enclosures: Encapsulated inflame retardant epoxy.
   2. For all Analog Signals Lines: EDCO PC-642 or SRA-64 series or approved equal.
   3. Field Mounted at Two-Wire Instruments: Encapsulated in stainless steel pipe nipples. EDCO SS64 series or approved equal.
   4. Four-Wire Instruments: With 120V ac outlet, ac circuit breaker, including surge suppressor for signal as well as 120V power line, all in enclosure. EDCO SLAC series or approved equal.

G. Installation and Grounding of Suppressors: As shown. See Surge Suppressor Installation Details. Coordinate surge suppressor grounding in field panels and field instrumentation with electrical contractor, and surge suppressor manufacturer's requirements. Furnish control panels with an integral copper grounding bus for connection of suppressors and other required instrumentation.

2.11 O&M MANUALS

A. Hardware:
   1. Provide the Following:
      a. Updated versions of all material described under paragraph Hardware Documentation.
      b. Component Manufacturers' O&M Manuals: Include manuals to cover installation, operation, maintenance, troubleshooting, and calibration.
      c. List of spare parts and expendables provided and list of spare parts recommended.

B. Software:
   1. Provide the Following:
      a. Programming Manuals: Component manufacturers' standard programming manuals.
      b. Software Documentation: Provide a final version of the material called for under Paragraph Software Design Submittal.

PART 3 - EXECUTION

3.1 ELECTRICAL POWER AND SIGNAL WIRING

A. Restrain control and signal wiring in control panels by plastic ties or ducts. Secure hinge wiring at each end so bending or twisting will occur around the longitudinal axis of wire. Protect bend area with a sleeve.

B. Arrange wiring neatly, cut to proper length, and remove surplus wire. Install abrasion protection for wire bundles passing through holes or across edges of sheet metal.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

C. Use manufacturer's recommended tool with sized anvil for crimp terminations. No more than one wire may be terminated in a single crimp lug. No more than two lugs maybe installed on a single screw terminal.

D. Do not splice or tap wiring except at device terminals or terminal blocks.

3.2 PROTECTION

A. Protect enclosures and other equipment containing electrical, instrumentation and control devices, including spare parts, from corrosion through the use of corrosion-inhibiting vapor capsules.

B. During Work, periodically replace capsules in accordance with capsule manufacturer's recommendations. Replace capsules at Substantial Completion.

3.3 SOURCE QUALITY CONTROL

A. General:
   1. Engineer and Owner may actively participate in many of the tests.
   2. Engineer and Owner reserve right to test or retest specified functions.
   3. Engineer's or Owner's decision will be final regarding acceptability and completeness of testing.
   4. Procedures, Forms, and Checklists:
      a. Except for Unwitnessed Factory Test, conduct tests in accordance with, and documented on, Contractor accepted procedures, forms, and checklists.
      b. Describe each test item to be performed.
      c. Have space after each test item description for sign off by appropriate party after satisfactory completion.
   5. Required Test Documentation: Test procedures, forms, and checklists signed by the Engineer.
   6. Conducting Tests:
      a. Provide special testing materials and equipment.
      b. Wherever possible, perform tests using actual process variables, equipment, and data.
      c. If not practical to test with real process variables, equipment, and data provide suitable means of simulation.
      d. Define simulation techniques in test procedures.
      e. Test Format: Cause and effect.
         1) Person conducting test initiates an input (cause).
         2) Specific test requirement is satisfied if correct result (effect), occurs.
   7. Test Plan:
      a. Provide a test plan outlining test procedures, descriptions, and checklists. An Engineer approved test plan is a pre-requisite to scheduling a factory test.

B. General Factory Test Requirements:
   1. Provide factory test of all Package Control system components before shipment to the Site.
   2. Engineer reserves the right to actively participate in and witness Factory Testing.
   3. Notify Engineer of Factory Testing 2 weeks in advance.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

4. Provide testing in accordance with general testing procedures listed above.
5. Test the following control system features as a minimum:
    a. Wiring from field and panel devices to the PLC.
    b. Signal inputs and outputs from the PLC.
    c. PLC control strategies.
    d. Interface with Operator interface and front of panel controls.
    e. Simulate inputs and outputs for primary elements, final control elements, and panels excluded from test.
6. Provide test documentation to the Engineer/Owner.

C. Factory Acceptance Test (FAT):
1. Notify Engineer and Owner of test schedule 4 weeks prior to start of test.
2. Scope: Test entire PLC control system to demonstrate it is operational.
3. Location: System Supplier's facility.
4. Correctness of wiring from panel field terminals to PLC system input/output points and to panel components.
    a. Simulate each discrete signal at terminal strip.
    b. Simulate correctness of each analog signal using current source.
5. Operation of communications between PLCs and remote I/O and between PLCs and computers.
6. Emulation of data exchange over Ethernet of the PLC control system and the Plant SCADA system.
7. Functional Requirements: Demonstrate System meets the functional requirements outlined in individual process equipment specifications.
8. Correct deficiencies found and complete prior to shipment to Site.
9. Failed Tests: Repeat and witnessed by Engineer.
10. Make following documentation available to Engineer at test site both before and during FAT:
    a. Drawings, Specifications, Addenda, and Change Orders.
    b. Master copy of FAT procedures.
    c. List of equipment to be tested including make, model, and serial number.
    d. Approved hardware Shop Drawings for equipment being tested.
11. Daily Schedule for FAT:
    a. Begin each day with meeting to review day's test schedule.
    b. End each day with each meeting to review day's test results and to review or revise next day's test schedule.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the complete installation of all components of bridge cranes.

B. Related Sections include Division 26 for associated electrical work.

1.3 SUBMITTALS

A. Submit the following in accordance with Division 01 Section "Submittal Procedures".

B. Shop drawings indicating:
1. Physical dimensions of equipment and accessories.
2. Dimensional tolerances required of building structure.
3. Connections, attachments, reinforcing; size and locations of loads and reactions on the building structure.
4. Configuration of controls and operators.

C. Manufacturer's Product Data describing materials, finishes, capacity and operating characteristics.

D. A complete description of the warranty to be provided.

E. Submit maintenance data in accordance with Division 01 Section "Operation and Maintenance Data".

F. Include description of operation and controls, signals, safety features and special or non-standard functions.

1.4 QUALITY ASSURANCE

A. All hoists, support structures, operators and controls shall meet requirements of HMI-100 published by the Hoist Manufacturer's Institute, and comply with OSHA safety requirements.

B. Cranes, monorail, trolleys and hoists shall be the product of a recognized manufacturer whose personnel have been regularly engaged in the design and manufacturing of such equipment. The manufacturer must be able to demonstrate experience with the design, fabrication, supply, and successful operation of bridge cranes of similar size and capacity. The manufacturer shall demonstrate upon the request of the Engineer that:
1. They maintain a reasonable stock of spare parts for this equipment.
2. They employ sufficient qualified servicing and operation control advice.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

C. Provide a list of references (name, location, and contact information) of at least three operating installations currently using the same or similar model proposed located in the United States.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Items to be shipped as complete assemblies except where partial disassembly is required by transportation regulations or for protection of components.

B. Protect equipment during storage and shipment in accordance with the manufacturer's recommendations.

1.6 WARRANTIES AND BONDS

A. The complete system shall be covered by a factory warranty, equipment and service, for a minimum of one year from the date of Substantial Completion.

B. Manufacturer's Certificate: The manufacturer will submit to the Engineer and Owner a written report certifying that the equipment has been satisfactorily installed and lubricated.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Bohnert Equipment Company, Inc. of Louisville, Kentucky.

B. EMH.

C. Yale.

D. Lift-Tech International.

E. Or approved equal.

2.2 EQUIPMENT TECHNICAL DATA

• Equipment Selection:	Top Running Single Girder Bridge Crane
• Capacity:	5 Ton
• Quantity:	One (1)
• Application:	Industrial
• Service:	Indoor
• CMAA Classification:	Class “C”
• Crane Span:	32'± (See Drawings to Verify)
• Bridge Girder:	Wide Beam Construction
• Runway Beam:	See Structural Drawings
• ASCE Crane Rail:	30 Lbs.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

• Runway Length:	105' ± (See Drawings To Verify)
• Runway Height:	See Drawings
• Clear Height:	See Drawings
• Maximum Wheel Load:	10,000 Lbs
• Power Supply:	460 Volt, 3-Phase, 60 Hertz
• Control Voltage:	120 Volt
• Enclosure Type:	Nema 4X
• Control Method	Sliding Pendant Along Full Width Of Crane Span.

2.3 HOIST TECHNICAL DATA

• Hoist Type:	Wire Rope
• Capacity:	5 Ton (verify with prepurchased equipment)
• Quantity:	One (1) Per Crane
• Available Lift On Hoist:	32’- 0” (See Drawings to Verify)
• Required Lift:	32’- 0” (See Drawings to Verify)
• Hook Height Above Deck	32'-0" (See Drawings to Verify)
• Lifting Speed:	20 and 3.3 FPM
• Lifting Motor:	16 / 2.5 HP
• Motor Insulation:	Class “F”
• Motor Rating:	TEFC – 60 Minute
• Hoist Reeving:	Two Part Single
• Wire Rope Diameter:	0.5”
• Brake Type:	D.C. Disc
• Upper Limit Switch:	Geared
• Lower Limit Switch:	Geared
• HMI Rating:	H 4
• Hoist/Trolley Weight:	1,800 LBS

2.4 TROLLEY TECHNICAL DATA

• Trolley Type:	Close Headroom
• Capacity:	5 Ton (verify with prepurchased equipment)
• Quantity:	One (1) Per Crane
• Travel Speed:	65 FPM (stepless)
• Travel Motor Rating:	TEFC – 60 Minute
• Travel Motor Hp:	0.6 HP
• Motor Insulation:	Class “F”
• Brake Type:	D.C. Disc
• Wheel Diameter:	Four (4) @ 5”

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2.5 END TRUCK TECHNICAL DATA

• End Truck Type:	Top Running Single Girder
• Capacity:	5 Ton (verify with prepurchased equipment)
• Travel Speed:	100 Fpm VFD
• Travel Motor:	Two (2) @ 0.50 HP
• Motor Rating:	Tefc – 60 Minute
• Brake Type:	D.C. Disc
• Wheel Diameter:	Four (4) @ 8”
• Wheel Base:	8’- 6”
• Overall End Truck Length:	10’- 2”

2.6 OPERATING AND SAFETY FEATURES

A. Thermal overload protection for all motors.

B. Class “F” insulation for all motors.

C. Equipment designed, engineered and manufactured in accordance with Crane Manufacturers Association of America specifications (CMAA).

D. Crane is equipped with a “C” track mounted festooned flat cable system to provide power to hoist / trolley.

E. Crane is equipped with a sliding push-button pendant across full width of span.

F. End trucks provided with variable frequency control for smooth acceleration and deceleration. Reduces load swing and increases overall safety. Electronic dynamic braking virtually eliminates brake wear.

G. End trucks provided with lifetime lubricated, totally enclosed gear trains and rotating axles.

H. Quick disconnect plugs provided for easy installation and service.

I. End trucks provided with OSHA approved bumpers.

2.7 ELECTRICAL

A. Electrical components shall be tested, approved, and labeled by UL.

B. Motors shall be designed for hoist service. They shall be drip proof or totally enclosed, and provided with antifriction bearings. Motors shall be rated on not less than 30-minute basis with temperature rise in accordance with NEMA Standards for the class of insulation and enclosure used.

C. Control panels shall contain individual automatic or manual reset thermal overload protection for each motor.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

D. Manual restart shall be required after power interruption.

E. Motor starters for drives shall be reversing type, fully magnetic, with both mechanical and electrical interlocks. Starters shall be sized for hoist duty consistent with horsepower requirements of drive and NEMA 4X industrial type enclosures shall be provided. Motors shall be as specified in Division 26.

F. Floor controlled units, unless otherwise specified, shall be controlled from a common pendant pushbutton station attached to the carrier so that the conductor does not carry the weight of the station.

G. Control voltage at pushbutton stations shall be 120V or less.

H. Power shall be brought to electrically operated units by means of semi- enclosed conductors mounted parallel to the rail for the entire length in compliance with Article 610 of NEC. Conductors shall be installed on insulating supports at intervals and spaced for electrical clearance. Conductor bars shall be coupled mechanically and electrically in entire system, and electrification shall be designed so that the current collector wheel or shoe does not lose contact with the conductor bar.

I. Collectors shall be wheel or shoe type. They shall permit normal contact with the conductor bar without causing mechanical strains on the supports or the conductor bar system.

J. All conduit and wire shall be sized in accordance with NEC.

K. Fused safety switch is furnished under Division 26 as indicated on the drawings. Manufacturer shall provide all electrical work from this point to all electrical components and motors.

L. For any motor supplied by equipment manufacturer, the equipment manufacturer shall provide monitoring capabilities as follows:
   1. For motors 15 hp and above:
      a. Voltage;
      b. Amps; and
      c. Kw-hours.
   2. For motors 50 hp and above:
      a. Voltage;
      b. Amps;
      c. Bearing temperature;
      d. Vibration; and
      e. Kw-hours.

2.8 LIGHTING

A. Provide 250W metal halide corrosion-resistant adjustable flood light mounted at top of hoist. Provide "on-off" lighting switch on pendant control. Fixture shall be equal to Hazlux Marine Grade fixture.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 3 - EXECUTION

3.1 INSPECTION

A. Verify that building structure is within tolerances and ready to receive crane rail work.

B. Verify that electrical provisions are complete and correct.

C. Beginning work indicates acceptance of existing conditions.

3.2 INSTALLATION

A. Install equipment in accordance with approved shop drawings and manufacturer's instructions.

B. Load carrying components shall be secured rigid, plumb and level.

C. Install conduit and wire in compliance with NEC guidelines from disconnect provided.

3.3 TEST AND ADJUST

A. When installation is complete, load test each hoist to 100% rated load capacity in the presence of the Installer, General Contractor and Engineer.

B. Adjust as necessary for smooth operation.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Related Sections include the following:
1. Division 01, Section “Submittal Procedures”.
2. Division 01, Section “Quality Requirements”.
3. Division 01, Section “Start-up Procedures”.
4. Division 01, Section “Operation and Maintenance Data”.
5. Division 01, Section “Demonstration and Training”.
6. All of Division 26.
7. All of Division 40.
8. Division 43, Section “Nitrogen Storage and Distribution System”
9. Division 44, Section “Indirect Dryer System”.

1.2 SUMMARY

A. This section describes the biosolids storage system consisting of a pneumatic conveyance system and a biosolids storage silo system.

B. Storage silo to be shop welded carbon steel tank complete with steel support structure with truck drive-through opening. The equipment and all appurtenances shall be installed as recommended by the manufacturer, and in compliance with all OSHA, local, state and federal codes and regulations.

C. All equipment included in this section shall be furnished by a single supplier who shall be responsible for the design, coordination, and satisfactory operation of the system. Any re-design required to accommodate the Owner for an approved equal system shall be borne by the system supplier.

1.3 DEFINITIONS / STANDARDS

A. American Concrete Institute (ACI).

B. American Institute of Steel Construction (AISC).

C. American National Standards Institute (ANSI).

D. American Society of Mechanical Engineers (ASME).

E. American Society for Testing and Materials (ASTM).

F. American Welding Society (AWS).

G. Concrete Reinforcing Steel Institute (CRSI).

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

H. Federal Aviation Administration (FAA).

I. International Building Code (IBC).

J. Kentucky Building Code (KBC).

K. National Electrical Manufacturers Association (NEMA).

L. National Fire Protection Association (NFPA).

1.4 SUBMITTALS

A. Product Data: Complete engineering data including, but not limited to, descriptive data, material specifications, performance data, and wiring diagrams. Differentiate between manufacturer-installed and field-installed wiring.

B. The following shall be included as a minimum in the shop drawings:
1. Certified process mechanical drawing with general arrangement showing principal dimensions and weights.
2. Piping layout, instrumentation diagram, pipe support schedule, pipe joint assembly details, underground conduit and grounding layout, and electrical layout.
3. Silo foundation plans, details, and calculations sealed by a professional engineer licensed in the State of Kentucky.
4. Pipe support plans, details, and calculations sealed by a professional engineer licensed in the State of Kentucky.
5. Descriptive literature regarding the silos and pneumatic conveying equipment to be supplied.
6. All dimensional drawings necessary to coordinate with structural, architectural, and other disciplines.
7. Cut sheets for electric motors and all ancillary items manufactured by others.
8. Performance of the transfer blower when operating at full load to confirm compliance with power input and capacity requirements.
9. Performance of air compressor for all pneumatically actuated components.
10. Horsepower calculations for drive motors.
11. Complete schematic diagrams for electrical and control panels.
12. Electrical single line diagram showing all power requirements.
13. Drawings of control panel including door layout, interior layout, ladder logic diagram, interconnects to all components outside of panel, and structural and mounting details.
14. Control system one line diagram and control schematics.
15. Installation instructions including leveling, alignment, pre-start-up checklist and initial start-up procedures.
16. Drawings of platforms showing dimensions and weights sealed by a professional engineer licensed in the State of Kentucky.
17. Proposed surface preparation and factory paint.
18. Materials of Construction for all major components and accessories.
19. A copy of this Specification Section with addenda updates and all referenced Sections to show Specification compliance or marked to show deviations.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

C. Number of Submittals: As specified in Division 01, Section "Submittal Procedures".

D. At the time of submission a copy of this specification shall be included where, the manufacturer shall, in writing, call the Owner's and Engineer's attention to any deviations that the submittal may have from the requirements of these Specifications.

E. All materials submitted for review shall be contained in one submission. Partial submittals will not be reviewed. Sales bulletins or other general publications are not acceptable for review, except where necessary to provide supplemental technical data.

F. Performance affidavit.

G. A complete written description of the warranty to be provided.

1.5 QUALITY ASSURANCE

A. Both the pneumatic conveyance system and biosolids storage silo system shall be products of a recognized system supplier whose personnel have been regularly engaged in the design and manufacturing of such equipment. The manufacturer(s) must be able to demonstrate experience with the design, fabrication, supply, and successful operation of a biosolids storage system of similar size and capacity. The manufacturer/supplier shall demonstrate upon the request of the Engineer that:
   1. They maintain a reasonable stock of spare parts for this equipment.
   2. They employ sufficient qualified technical personnel to insure adequate servicing and operational control advice.

B. Provide a list of references (name, location and contact information) of at least three installations that have been in full operation using the same or similar model(s) proposed located in the United States.

C. All parts of the equipment provided to be designed and manufactured for long, continuous and uninterrupted service. All materials used to be of best quality and entirely suitable for service required.

D. Identification: The specified system shall be identified with corrosion-resistant nameplates, securely affixed in a conspicuous location. Nameplate information shall include equipment model number, serial number, and supplier's name and location.

1.6 DELIVERY, STORAGE AND HANDLING

A. Ship items as complete assemblies except where partial disassembly is required by transportation regulations or for protection of components.

B. Protect equipment during storage and shipment in accordance with the manufacturer's recommendations.

C. Spare Parts: Packed in containers, labeled clearly with part number, designating contents, and pieces of equipment.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1.7 WARRANTIES AND BONDS

A. All equipment supplied under this section shall be warranted by the Contractor for a minimum of one (1) year from the date of equipment start-up or from the date of Engineer's acceptance of the equipment for permanent operation, whichever is later.

B. The equipment shall be warranted by the manufacturer free from defects in workmanship, design and materials. If any part of the equipment should fail during the warranty period, it shall be replaced at no expense to the Owner.

C. Manufacturer's Certificate: The biosolids storage system manufacturer will submit to the Engineer and Owner, a written report certifying that the equipment has been satisfactorily installed.

1.8 START-UP AND TRAINING SERVICES

A. Manufacturer shall include a minimum of three (3) three-day trips, exclusive of travel time, for the purpose of supervising installation, start-up and instruction of Owner's personnel in proper operation and maintenance. Manufacturer shall also include one (1) week, exclusive of travel time, for product performance testing.

B. Minimum services to be provided by manufacturer's factory representative while on site:
   1. Observe, inspect and approve installation – 3 days.
   2. Supervise initial adjustment – 1 day.
   3. Supervise field run test – 3 days.
   4. Product performance test - 1 week.
   5. Instruct Owner in proper start-up and O&M – 2 days.

PART 2 - PRODUCTS

2.1 GENERAL

A. The biosolids storage system consists of a pneumatic conveyance system and biosolids storage silo system.
   1. Pneumatic Conveyance system includes a surge bin, pneumatic educator or rotary valve, two (2) positive displacement transfer blowers, conveying line to the storage silos, and all necessary controls and appurtenances.
   2. Silo System includes two (2) 150 cubic yard storage silos with foundation systems, four (4) load cells per silo, one (1) level sensor per silo, one (1) "rope" type temperature monitor with multiple sensors per silo, one (1) carbon monoxide sensor per silo, one (1) oxygen sensor per silo, nitrogen system for fire suppression, one (1) three way diverter valve, two (2) knife gates per silo, one (1) air compressor, one (1) bag house per silo, two (2) vibrating dischargers per silo, one (1) electric load out spout per silo, mineral oil system with metering pump, an access platform at the 14-ft level with stair access from ground level, safety cages and ladders from platform level to top of each silo, explosion panel(s) with platform access, control panel with PLC and PanelView HMI, and all necessary controls and appurtenances.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. System supplier shall comply with the "Loop Descriptions" in Division 40, Section "Process Control Software".

2.2 ACCEPTABLE MANUFACTURERS

A. BioSec Enviro Inc., of Milton, Ontario

B. Industrial Accessories Co., of Mission, Kansas.

C. LB Industrial Systems, of San Antonio, Texas.

D. LECORP, Inc., of Paducah, Kentucky.

E. Or approved equal.

2.3 PERFORMANCE CRITERIA

A. Biosolids Material Characteristics:

1.	Approximate Density (lb/ft^3):	45
2.	Average Particle Size (mm):	1-4
3.	Maximum Particle Size, <5% (mm):	10
4.	Minimum Percent Solids (%):	90
5.	Temperature (^oF):	122
6.	Explosion Rating	
	a. (k_{st}):	100 - 120
	b. Pmax (bars):	7

B. Pneumatic Conveyance System:

1.	Biosolids Discharge Rate from Cooling Conveyor (lbs/hr):	2,000 - 2,500
2.	Height Restriction from Finished Floor to Cooling Screw (ft):	4'-8"

C. Storage Silo System:

1.	Insulation:	None required.
2.	Tank Heating:	None required.
3.	Minimum Slope for Cone:	60 degrees from horizontal

2.4 PNEUMATIC CONVEYANCE SYSTEM

A. Manufacturer to provide performance guarantee on material conveying system.

B. Biosolids from the indirect dryer's cooling conveyor (by others) are to be discharged into a surge bin connected to a pneumatic eductor (or rotary feeder). The pneumatic eductor or rotary feeder with all valving shall be connected to the transfer blowers to convey the biosolids into the storage silos. Surge bin with pneumatic eductor (or rotary feeder) shall comply with height restriction specified. Connections shall be air tight and include all necessary appurtenances.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

C. Surge Bin:
   1. Surge bin to fit within height restrictions specified in this section and be constructed using abrasive resistant materials. The width restriction for the vessel shall be 3'-0". If footprint restrictions cannot be met, the system suppler is responsible for any and all costs for equipment and/or building modifications.
   2. A sample port on the surge bin shall be supplied for dried product sampling.

D. Pneumatic Eductor or Rotary Feeder:
   1. Biosolids will be discharged from the cooling conveyor off the dryer into the surge bin. From the surge bin either a pneumatic eductor or a rotary feeder shall be supplied to discharge the biosolids into the air stream provided by the transfer blowers. The biosolids will then be transferred into the storage silos.
   2. Pneumatic Eductor:
      a. The pneumatic eductor shall be stainless steel with replaceable Alumina Ceramic Liner, or approved equal.
      b. Suction inlet shall be 150# Flanged. Discharge shall be plain pipe as specified in Division 40 Section "Process Piping".
      c. Motive Nozzle shall have adjustable position.
      d. Pneumatic eductor shall be controlled, using the transfer blowers, powered and controlled from the Motor Control Center.
      e. Model/Manufacturers: Pneumatic eductor shall be a Fox Venturi Eductor by Fox Valve of Dover, NJ, or approved equal.
   3. Rotary Feeder:
      a. Rotary Feeder shall be sized based on necessary ft^3/rev required to discharge biosolids into air stream for transfer blowers.
      b. Housing shall be stainless steel with 0.005-inch machined chrome plating and headplate internals. Feeder shall be able to handle necessary pressure differentials and withstand temperatures up to 150^oF.
      c. Rotor shall be 8-vane type, open end rotor with stellited ends, stainless steel, with fabricated beveled tips, air purged shaft seals with purge control set.
      d. Drive shall have outboard bearings with standard graphite impregnated Aramid Fiber packing, or approved equal and Type D conveying line adapter to Type 304 stainless steel Schedule 10S pipe line.
      e. Rotary Feeder shall be controlled by BSSCP-7040, the silo control panel.
      f. At a minimum, drive shall be 2 HP, TEFC, right angle wormgear reducer, 460V, 3 phase, 60 Hz, 1800 rpm, premium efficient motor with severe duty roller chain drive and guard.
      g. Model/Manufacturers: Rotary Feeder shall be a Series HDX Extra Heavy Duty Square Flange Airlock Feeder by Wm. W. Meyer & Sons, Inc. of Libertyville, IL, or approved equal.

E. Transfer Blowers: Two (2) transfer blowers with appurtenances are to be provided to convey the biosolids into the storage silos. Power and control for the transfer blowers shall be from the motor control center.
   1. Footprint for blowers is limited to 6'W x 20'L, if larger footprint is required system supplier is responsible for any costs required to make building modifications. Blowers are to be located on the north side of the dryer with walking room around the blowers and piping. Minimize trip hazards when running conveying line piping.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2. Blower shall be sized to keep up with discharge cooling conveyor and convey material to the storage silos. At a minimum the blower shall supply 875 icfm @ 15 psig.
3. At a minimum system to include:
   a. Sound attenuation enclosures so that the maximum noise level at 3-feet free field distance any direction shall be 80 dBA or less. The enclosure shall be easily removable for inspection and maintenance.
   b. TEFC, 480 Volt, 3 phase, 60 HZ high efficiency drive motor.
   c. V-belt drive with OSHA approved belt guard.
   d. Inlet filter assembly with inlet silencer with polyester element and foam pre-filter.
   e. Flanged discharge flex joint.
   f. Chamber type discharge silencer.
   g. Discharge temperature switch with adjustable dial for set point calibration.
   h. Discharge pressure relief valve.
   i. Discharge pressure gauge with 2-1/2" dial.
   j. Wafer type discharge check valve and all required fittings, fasteners, and gaskets.
   k. A butterfly control valves and all required fittings, fasteners, and gaskets, as specified in Division 40 Section "Process Valves".
4. Valves: Valves shall be compatible with Division 40 Section "Process Valves".
5. Instrumentation: Dual set point pressure switch rated NEMA 4, pressure gauge with 2.5" dial, discharge temperature switch with adjustable dial for set point calibration, and pressure relief valve set at 12 psi. All instrumentation shall be compatible with instrumentation specified in Division 40, Section "Instrumentation and Control Components".
6. Sound Attenuation Enclosure: At a minimum, 2" acoustical polyurethane foam for maximum absorption efficiency. Polyurethane foam shall be resistant to heats and oils.
7. Electrical Drive: Minimum of 40 HP, TEFC, 480V, 3 phase, 60 Hz, premium efficiency, 1750 rpm, T-frame motor mounted on an adjustable base. V-belt drive with guard, set at 1800 rpm.

F. Conveying Pipeline: A conveying pipeline between the transfer blower and silo shall be sized and supplied by the system supplier.
   1. Conveying pipeline shall be sized to handle volume specified in this section. Conveying line shall use a 3-way diverter valve (specified in this section) to convey the biosolids into the top of each silo.
   2. Valves, supports, and all necessary appurtenances required for a complete system shall also be supplied by the system supplier.
   3. Pipe material and fittings shall be as specified in Division 40, Section "Process Piping".
   4. All pipe connections shall be bolted gasketed flanged joints unless otherwise approved by the Engineer.
   5. As seen on the drawings, if desired, system supplier may use roof structure of boiler room for support of conveying line to the silos. All other pipe supports shall comply with Division 40 Section "Process Piping" or be designed and sealed by a Professional Engineer licensed in the State of Kentucky.

2.5 STORAGE SILO SYSTEM

A. Storage Silos:
   1. Storage silos to be shop welded carbon steel tanks complete with steel support structure, access platforms, and 14' x 14' clear truck drive through opening.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2. Design and fabrication of structural steel shall be in accordance with the AISC "Code of Standard Practice" (latest edition).
3. All welding shall conform to the specifications of the AWS.
4. Storage silo manufacturer to design foundation system to be stamped by professional engineer licensed in the State of Kentucky. Concrete design shall be in accordance with ACI 318 (latest edition).

B. Instrumentation:
1. Load Cells:
   a. Each support for the silo shall have a load cell (minimum of 4 per silo, total of 8) with controls to be used for continuously monitoring the weight of material within the silo on the SCADA system.
   b. Manufacturer to provide a closed loop level control system.
   c. Each weighing assembly shall consist of a nickel plated load cell of the shear beam strain gauge type and all appropriate mounting hardware.
   d. A flexible cable shall connect each load cell to the indicators for easy remote installation of the readout. Cable lengths shall be a minimum of 100 feet.
   e. Weighing assemblies shall be self-checking and have provisions for thermal expansion and contraction. Weighing assembly load plate shall be able to compensate for mounting surfaces up to 4 degrees off-level.
   f. A 4½ digit LCD indicator shall be housed in the silo control panel. LCD Indicator shall be backlit with 0.5" characters for ease of readability in low light conditions.
   g. Indicator shall output net weight using a 4-20mA signal. Indicator shall have two adjustable set points for alarms or level control. Indicator to be hard wired to Silo's PLC which will send a signal via Ethernet to the SCADA system.
   h. Approved Manufacturers:
      1) Kistler-Morse, of Spartanburg, SC.
      2) Mettler Toledo of Columbus, OH.
      3) Sartorius Mechatronics Corp., of Edgewood, NY.
      4) Or approved equal.
2. Level Sensors: Equipment supplier to provide one rotary paddle bin monitor in each silo (total of 2).
   a. The level sensor shall be located near the maximum fill height of the silos as recommended by the silo equipment supplier (approximately 1 – 2 ft below the explosion panel(s)). Monitor shall be positioned and accessible from the access platform off the vertical ladder.
   b. Paddle shall be a standard stainless three vane paddle (7.00 inch).
   c. Power requirements: 120 VAC, 60 Hz
   d. Conduit connections: Two (2) ¾" NPT
   e. Output contacts: Two SPDT 15A
   f. Materials of construction/accessories:
      1) Flexible coupling: 304 stainless steel
      2) Mounting plate: 304 stainless steel
      3) All paddles: 304 stainless steel
      4) Flexible cord extension: 304 stainless steel
      5) Solid shaft extension/guards: 304 stainless steel
      6) Shaft seal: 304 stainless steel
   g. Model/Manufacturer: The rotary paddle bin monitor shall be a Model KAX as manufactured by Monitor Technologies LLC, Elburn, IL or approved equal.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3. Temperature Sensors:
   a. Two (2) temperature sensors shall be provided by the system supplier to monitor the temperature of the biosolids inside the silo. One temperature sensor per silo to be hung from a hook mounted in middle of each silo.
   b. Temperature sensor to be "rope" type with copper-constantan (57% copper and 43% nickel) thermocouple sensors. It shall have a rugged, glossy-smooth outer cable jacket which reduces friction and resists chemicals. Semi-transparent cable jacket allows for visual location of each thermocouple sensor. Outside jacket shall be UV stabilized.
   c. Cable shall extend the length of the silo (top to bottom), however the thermocouple shall extend, without splicing, the length of the silo plus the length to the PLC mounted at ground level.
   d. Temperature sensors to be Regular Duty type with the following:
      1) 12 Sensing Points
      2) 4200 lbs. Tensile Strength
      3) 6ft Thermocouple Spacing
      4) Nylon Outer Jacket
   e. Model/Manufacturers: The temperature sensor shall be a Regular Duty Model by Rolfes @ Boone of Boone, IA, or approved equal.
4. Carbon Monoxide Sensor: To be provided by the Contractor, reference Division 40, Section "Instrumentation and Control Components". Control for the carbon monoxide sensor shall be from the Silo's PLC supplied by the system supplier. System supplier to coordinate I/O with Contractor.
5. Oxygen Sensor: To be provided by the Contractor, reference Division 40, Section "Instrumentation and Control Components". Control for the oxygen sensor shall be from the Silo's PLC supplied by the system supplier. System supplier to coordinate I/O with Contractor.
6. Nitrogen System: A nitrogen system shall be provided by the Contractor for fire suppression. See Division 43 Section "Nitrogen Storage and Distribution System". Control of the nitrogen system for the silos shall be from the Silo's PLC supplied by the system supplier. System supplier to coordinate I/O with Contractor. The cone portion of each silo shall have a minimum of two (2) connection points for the nitrogen system spaced 180 degrees apart.
7. Pressure relief valves and access points to the instrumentation shall be provided by Manufacturer. Pressure relief valve shall be Enardo Pressure Vacuum Relief Valve Model 550, or approved equal. Valve to have carbon steel housing, stainless steel pallet, and sized for 5 ounce relief of required air flow.

C. 3-Way Diverter Valve
1. Fill selection of the silos shall be via a 3-way diverter valve that will be controlled through the silo's PLC control panel (BSSCP-7040).
2. The diverter valve housing shall be constructed of cast iron with replaceable elastomer sleeve. A hardened carbon steel diverter blade shall pivot on two flanged bearings that allow it to open and close. Seals shall be designed to eliminate product leakage when the blade is in the diverted position.
3. Actuation of diverter valve shall be pneumatic. An air compressor (specified in this section) shall supply the required air to the 3-way valve.
4. Solenoid valve shall be NEMA 4 with 120 volts. Limit switches shall be NEMA 4, SPDT.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

5. Pneumatic Operator (A3):
   a. Operator shall be designed for "quarter-turn" operation and shall be direct mounted. It shall be able to produce output torque up to 13,444 lb-in. Pneumatic actuator shall travel a minimum of 90 degrees in each direction and must be able to over-travel at 3% in each direction past 90 degrees. Actuator shall be totally enclosed and contained in a single enclosure, with no moving parts. Actuator shall be able to mount in any position without loss of performance.
   b. Materials of Construction: At a minimum, Type 304 Stainless Steel with flanged end connection and UV protection. Materials shall have high reliability and long life.
   c. Approved Manufacturers:
      1) Bray Controls.
      2) Tyco International.
      3) Or approved equal.
6. Model/Manufacturer: The 3-way valve shall be Model DV8 by Semco-TBS of Milton, Ontario, or approved equal.

D. Knife Gates:
1. Two knife gates per silo shall be provided by the system supplier to shut off product flow (total of 4). The first knife gate off the cone portion of the silo shall be manual and underneath the manual knife gate shall be a pneumatic knife gate. An air compressor (specified in this section) shall supply the required air to the pneumatically operated knife gates.
2. Knife gate shall be fabricated entirely of AISI 316 stainless steel and suitable non metallic (UHMW PE) components, all minimum 3/16" thickness. The UHMW PE shall have a machined groove to accept the gate blade and give a positive seal. Roller gates are not allowed due to increased and difficult maintenance requirements.
3. Manual Operator (A1): Shall comply with Division 40, Section "Process Valves".
4. Pneumatic Operator (A3):
   a. Operator shall be designed for "quarter-turn" operation and shall be direct mounted. It shall be able to produce output torque up to 13,444 lb-in. Pneumatic actuator shall travel a minimum of 90 degrees in each direction and must be able to over-travel at 3% in each direction past 90 degrees. Actuator shall be totally enclosed and contained in a single enclosure, with no moving parts. Actuator shall be able to mount in any position without loss of performance.
   b. Materials of Construction: At a minimum, Type 304 Stainless Steel with flanged end connection and UV protection. Materials shall have high reliability and long life.
   c. Approved Manufacturers:
      1) Bray Controls.
      2) Tyco International.
      3) Or approved equal.
5. Model/Manufacturer: Knife gates shall be Model SV by DCL of Charlevoix, MI, or approved equal.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

6. Knife Gate Schedule:

Gate ID	Type	Size	Head	Operator
BSKV-7981A1	Knife	14” x 14", or match size of cone on silo	Unseating	Manual
BSKV-7982A3	Knife	14” x 14", or match size of cone on silo	Unseating	Pneumatic
BSKV-7881A1	Knife	14” x 14", or match size of cone on silo	Unseating	Manual
BSKV-7882A3	Knife	14” x 14", or match size of cone on silo	Unseating	Pneumatic

E. Air Compressor: An air compressor shall supply air to pneumatic valves, bag house, and vibrators (if desired) within the biosolids storage system. Air compressor shall be sized for a minimum of 40 scfm @ 100 psi, however system supplier shall size air compressor based on supplier’s system requirements. At a minimum, the bag house requires 16 cfm @ 80 psi, pneumatic valves require 10 cfm @ 90 psi, and (if the system supplier elects) the vibrator requires 12 cfm @ 100 psi. System supplier shall field locate the air compressor outside near the silos. If foundation system is necessary, system supplier shall be required to provide foundation design sealed by professional engineer licensed in the State of Kentucky. Control shall be from the silo’s PLC control panel (BSSCP-7040).

F. Bag House: Air vent filters are to be mounted on the roof and are to be used to vent the silos.
1. Bag house to have pleated bag pulse jet filter cleaning bin vents, with pleated filter bags of 100% spunbond polyester with 180^{o}F maximum operating temperature. Bag to be side removal type with manifold mounted solenoid operated diaphragm valves with automatic timer card and photohelic differential pressure gauge. Each shall be prewired to solenoids integral with diaphragm valves that is to be integrated into the silo control panel. The bag catch grating to have 20” x 20” access panel mating flange.
2. At a minimum, System Supplier shall provide 300 ft^2 of polyester felt filtration media. The air to cloth ratio shall be 4.2:1 and sized for a minimum of 1400 cfm air withdrawl. Withdrawal fan shall supply 1400 cfm @ 8" W.C. with a minimum of a 5 HP, TEFC motor. Fan shall be direct drive and provided with a flanged inlet for direct interface with the filter module and an outlet damper for withdrawal throttling. Compressed air shall be supplied at 16 cfm @ 80 psi from the system supplier’s air compressor.
3. Materials of Construction: 10 Ga. Carbon steel housing with clean air plenum; 7 Ga. Carbon steel tube sheet with ¼” flat bar stiffeners; davit arm assist mechanism for removal of clean air plenum lid; 8”x8” exhaust port with weatherhood and birdscreen.
4. Filter Media: A minimum of 8 oz Spun Bond polyester, 5.75” x 36” side load pleated element cartridge, 30 pleat count, 1.1875 pleat dept, polyurethane top boot galvanized core, with 304 stainless steel ground wire, and 17.8 ft^2 media per unit.
5. Finish shall comply with Division 09, Section “Protective Coatings”.

G. Vibrating Discharges:
1. Two (2) vibrating discharges shall be supplied per silo (total of 4). Vibrators shall be located on opposite sides of the cone portion of each silo.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2. Vibrators can be pneumatic or electric.
   a. If pneumatic, air supply shall come from air compressor provided by system supplier. Pneumatic actuator shall be as specified in this Section, manufactured by Bray Controls, Tyco International, or approved equal. Air consumption shall be around 12 scfm at 100 psi regulated to 20-60 psi during operation.
   b. If electric, the motor shall be on 480 volts, 3 phase, 60 Hz power supply. Controls shall be suitable for 120 volt, 60 Hz power supply.
3. Model/Manufacturer: Vibrating Discharge shall be Model BH as manufactured by National Air Vibrator Company (NAVCO®) of Houston, TX or approved equal.

H. Load Out Spout:
1. A retractable loading spout for directing biosolids into a receiving truck shall be provided by the system supplier.
2. The spout shall be able to rise free and clear of truck passage, and be able to lower to the level of the empty trailer bed. Load out spout shall be able to retract a minimum of 45-ft with a 10-ft travel. The extension and retraction of the spout shall be automatically controlled through the cable hoisting system provided by an electronic motor and controlled by a level sensor.
3. The load out spout shall be mounted directly onto the silo after the knife gates and mineral oil injection.
4. Load out spout shall include the Compact Filter Module to be used for dust suppression. Dust shall be collected and re-entrained with the material being loaded. The Compact Filter Module will be used for clients who don't want the mineral oil in their final product. The Owner will determine when each dust suppression system will be used.
5. Control for the loading spout to be integrated into the silo's PLC.
6. Model/Manufacturers: Load Out Spout shall be Model Spout/CFM Combination by DCL of Charlevoix, MI, or approved equal.

I. Mineral Oil System:
1. A dust suppression system using mineral oil, or approved equal, shall be provided to remove fugitive dust from the product as it discharges through the load out spout. An injection ring with 3 ports shall be supplied and located after the knife gates but prior to the load out spout.
2. Storage tank shall be 1,200 gallons (minimum) and shall maintain the mineral oil at a temperature of 120^{o}F. A metering pump shall be provided to feed the mineral oil at a rate of 0-5 gallons per hour.
3. System shall include at a minimum: a 30-day supply of mineral oil, all required valving, differential pressure switch, storage tank, metering pump, tank filling piping, vents, level sensors, temperature sensors and controls necessary for proper operation. All instrumentation, piping and valves supplied with the mineral oil system shall comply with Division 40 Sections "Process Valves," "Process Piping," "Instrumentation and Control Components," and the "Loop Descriptions" in "Process Control Software". Instrumentation shall be suitable for operation on 120 volts, 60 Hz power supply. Control will be via the silo's PLC.
4. Foundation system for mineral oil and metering pump to be designed by a professional engineer licensed in the State of Kentucky. Concrete design shall be in accordance with ACI 318 (latest edition) "Building Code Requirements for Reinforced Concrete". Concrete pad shall be located near silos as shown on the drawings.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

J. Access Platforms and Stairs:
   1. A platform with stairs shall be provided at approximately 14-ft from the finished ground elevation to access the loading spout, knife gates, vibrator, and all appurtenances at that level. Platform to allow access to either silo at the 14-ft level.
   2. A vertical ladder with safety cage shall be provided from the platform to the roof level. Vertical ladder shall be separated into sections that meet OSHA standards for safety.
   3. The roof shall have deck guard railings and 36" x 36" inspection opening into the top of each silo.
   4. Access to the bag house and explosion panel(s) shall be provided with all applicable handrails around the platform access.

K. Explosion panel(s): Explosion panel(s) shall be provided near the top of each silo. Explosion panel(s) shall conform to all applicable NFPA and OSHA standards.

2.6 PAINTING

A. Painting shall comply with Division 09, Section "Protective Coatings".

2.7 ELECTRICAL / CONTROL SYSTEM

A. Electrical and Control System must comply with Division 26 and Division 40 specification sections. An Allen Bradley ControlLogix PLC with PanelView HMI, or approved equal, shall be supplied as specified in Division 40, Section "Programmable Logic Process Controllers". In addition to the requirements of Section "Programmable Logic Process Controllers", a PLC thermocouple module must be used to monitor the silos temperature.

B. Pneumatic System's power and control shall be through the Motor Control Center and should include control for the surge bin, pneumatic eductor (or rotary feeder), and transfer blowers.

C. Silo System's control panel shall be housed in a NEMA 4X enclosure and follow all NFPA requirements. Control panel with PLC and PanelView HMI shall be located at the ground level on the south side of the silos with easy access from the Sales Office and Dryer Building. Control for the following components shall be included: 3-way diverter valve, temperature sensor, level sensor, oxygen sensor, carbon monoxide sensor, knife gates, load out spout, mineral oil system, nitrogen system, bag house, air compressor, and all applicable appurtenances associated with the silo system. Control panel shall include the following items:
   1. Cycle start;
   2. Cycle stop;
   3. Up/down control of silo spout;
   4. Hand/Off/Auto for load cells;
   5. Hand/Off/Auto for all valves and instrumentation;
   6. Hand/Off/Auto for the blowers;
   7. Hand/Off/Auto for the Mineral Oil System;
   8. Hand/Off/Auto for the air compressor;
   9. Control power On/Off;
   10. And any other functions required for a complete and operable system.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

D. The pneumatic system and silo system shall communicate via Ethernet over the SCADA system to each other and the Dryer's PLC. Reference the "Loop Descriptions" in Division 40, Section "Process Control Software" for control logic.

2.8 SPARE PARTS

A. Two (2) belts for the transfer blowers.

B. Two (2) filters for the bag house.

C. One (1) load out spout.

D. Anchor bolts and nuts.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install the biosolids storage system and all appurtenances in accordance with manufacturer's recommendations.

B. Align, adjust, and lubricate all applicable components in accordance with manufacturer's instructions and leave in proper working condition.

C. All final electrical connections shall be made by Electrical Contractor.

3.2 INSPECTION

A. Inspect the biosolids storage system for shipping damage and to ensure that all accessories arrived undamaged and are in conformance with the specifications.

B. Check all electrical system components for proper connections.

C. Touch up factory coating as required.

3.3 FIELD QUALITY CONTROL

A. Inspection and Check-out:
   1. Prior to operating, complete the inspection, testing, and check-out of supporting systems, including but not limited to power systems, control systems and safety systems.
   2. Complete electrical system shall be tested to ensure proper function.

3.4 START-UP, TESTING, AND TRAINING

A. Start-Up:
   1. The manufacturer shall demonstrate system performance per the requirements identified herein to the Owner or Engineer as a condition of acceptance. Written confirmation of

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

acceptance of the system performance by the Owner shall be provided by the Manufacturer to the Contractor.

2. Transfer Blowers:
   a. A 1 PSI slip test shall be performed on each blower to verify flow within +/-5%.
   b. A package mechanical run test at contract speed and pressure shall be performed on each blower.
   c. Package noise certified readings, which include the mechanical run test, and calculated to a free field environment. Test to be measured to CAGI-PNEUROP test code with +/- 3 dBa tolerance.
3. Run system from minimum to maximum specified speed to assure that no damage has occurred during shipment that may affect the performance.

B. Testing:
1. Inspection of field installation and wiring of equipment.
2. Field testing of all equipment provided under this section, verification of proper operation, confirmation of performance requirements, and initial system tuning.
3. A CSV (Comma Separated Variable) file containing a list of all PLC registers and addresses required for the SCADA system to access process performance data, alarm and equipments status information, and critical control system setpoints shall be provided to the SCADA system supplier after submittal approval. An updated “as built” file shall be provided after completion of system field testing and system start-up.
4. Coordination of the interface between equipment provided under this section but not included in the scope of supply of this section. Copies of the appropriate submittals shall be provided to the SCADA system manufacturer for use in coordination with the control system requirements.

C. Training shall comply with Division 01 Section "Demonstration and Training".

3.5 PRODUCT PERFORMANCE TEST

A. Biosolids storage system shall be tested with dried product. In addition to the requirements of Division 01, equipment supplier shall include one week at initial start-up for the dryer, exclusive of travel time. Therma-Flite personnel shall be present to verify dried product meets Class A requirements and all other product performance testing. Biosolids storage system supplier shall verify pneumatic system conveys the dried product into the storage silos and that the product in the storage silos is stored and discharged properly.

B. It is estimated at build out the dryer will process approximately 2,500 pounds per hour of biosolids at 90 percent solids concentration, five days a week, 24 hours a day. The pneumatic system shall transfer this amount of biosolids when the dryer is in operation.

3.6 MANUFACTURER’S FIELD SERVICES

A. The biosolids storage system supplier shall furnish the services of a factory-trained representative. Service shall be provided as necessary after the Contractor has installed the equipment. Training the Owner's personnel shall comply with Division 01 Section "Demonstration and Training".

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. These services shall be furnished for the purposes of the equipment manufacturer's inspection of the equipment following installation, and to certify that the equipment has been properly installed and is ready to operate, to train the Owner's personnel in operation, maintenance of the equipment, and to observe and supervise the initial operation of the equipment.

C. The Contractor shall coordinate the Manufacturer's technical services in a timely professional manner. At a minimum, two weeks notice must be given to the Manufacturer for travel planning purposes unless previously agreed by Manufacturer. To avoid project delays, every effort should be made to coordinate inspection, training, and start-up of the equipment.

D. After inspection of the installed equipment the Manufacturer shall furnish a written report certifying that the equipment has been properly installed and lubricated, is in accurate alignment, is free from any undue stress imposed by connecting piping or anchorage, has been operated under full load conditions and that it operates satisfactorily

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Related Sections include the following:
1. Division 01, Section “Submittal Procedures”.
2. Division 01, Section “Quality Requirements”.
3. Division 01, Section “Start-up Procedures”.
4. Division 01, Section “Operation and Maintenance Data”.
5. Division 01, Section “Demonstration and Training”.
6. Division 40, Section “Instrumentation and Control for Process Systems”.
7. Division 40, Section “Instrumentation and Control Components”.
8. Division 41, Section "Biosolids Storage System".
9. Division 44, Section “Indirect Dryer System”.

1.2 SUMMARY

A. This section covers the nitrogen storage system, vaporizer, the distribution piping, gas pressure gauges, gas level gauges, regulators, gas safety equipment, and all related appurtenances. Nitrogen gas will be distributed to three locations: biosolid’s silos, biosolid’s dryer, and thermal fluid expansion tank. The Contractor shall be responsible for connections to all three locations.

B. System supplier shall be responsible for the design and coordination of the foundation system for nitrogen tank. Foundation system to be designed by a professional engineer licensed in the State of Kentucky. Drawings and calculations shall be submitted to the Engineer with shop drawings. Concrete pad shall be located near the silos as shown on the drawings.

C. Provide a complete design of the system proposed including all storage tank, piping, regulators, safety components, and appurtenances for approval by the Engineer. The equipment and all appurtenances will be installed as recommended by the manufacturer, and in compliance with all OSHA, local, state and federal codes and regulation.

1.3 DEFINITIONS / STANDARDS

A. American National Standards Institute (ANSI).

B. American Society of Mechanical Engineers (ASME).

C. American Society for Testing and Materials (ASTM).

D. International Building Code (IBC).

E. Kentucky Building Code (KBC).

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

F. National Electrical Manufacturers Association (NEMA).

G. National Fire Protection Association (NFPA).

1.4 SUBMITTALS

A. Product Data: Complete engineering data including, but not limited to, descriptive data, material specifications, performance data, and wiring diagrams. Differentiate between manufacturer-installed and field-installed wiring.

B. For approval the nitrogen storage tank supplier shall submit the following:
   1. A complete design of a nitrogen storage and distribution storage tank, piping, valves, safety components and appurtenances. The system shall be designed by a professional engineer licensed in the State of Kentucky. Design calculations shall be submitted to the Engineer.
   2. Complete fabrication, assembly, layout and connecting drawings, including plans, elevations, sections and details as necessary to accurately and completely depict the equipment and piping to be provided.
   3. Foundation plans, details, and calculations sealed by a professional engineer licensed in the State of Kentucky.
   4. Complete schematic diagrams for electrical control panel.
   5. Electrical single line diagram showing all power requirements.
   6. Drawings of control panel including door layout, interior layout, electrical ladder diagram, interconnects to all components outside of panel, and structural and mounting details.
   7. Installation instructions including leveling, alignment, pre-start-up checklist and initial start-up procedures.
   8. A copy of this Specification Section with Addenda updates, and all referenced Sections to show specification compliance or marked to show deviations.

C. Number of Submittals: As specified in Division 01, Section “Submittal Procedures”.

D. At the time of submission, the manufacturer shall, in writing, call the Owner’s and Engineer’s attention to any deviations that the submittal may have from the requirements of these Specifications.

E. All materials submitted for review shall be contained in one submission. Partial submittals will not be reviewed. Sales bulletins or other general publications are not acceptable for review, except where necessary to provide supplemental technical data.

F. Performance affidavit.

G. A complete written description of the warranty to be provided.

1.5 QUALITY ASSURANCE

A. The nitrogen storage and distribution system shall be the product of a recognized manufacturer whose personnel have been regularly engaged in the design and manufacturing of such equipment. The manufacturer must be able to demonstrate experience with the

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

design, fabrication, supply, and successful operation of a nitrogen storage system of similar size and capacity. The manufacturer/supplier shall demonstrate upon the request of the Engineer that:

1. They maintain a reasonable stock of spare parts for this equipment.
2. They employ sufficient qualified technical personnel to insure adequate servicing and operational control advice.

B. Provide a list of references (name, location and contact information) of at least three installations that have been in full operation for 5 years using the same or similar model proposed located in the United States.

C. All parts of the equipment provided to be designed and manufactured for long, continuous and uninterrupted service. All materials used to be of best quality and entirely suitable for service required.

D. Identification: The specified system shall be identified with a corrosion-resistant nameplate, securely affixed in a conspicuous location. Nameplate information shall include equipment model number, serial number, and supplier's name and location.

1.6 DELIVERY, STORAGE AND HANDLING

A. Ship items as complete assemblies except where partial disassembly is required by transportation regulations or for protection of components.

B. Protect equipment during storage and shipment in accordance with the manufacturer's recommendations.

C. Spare Parts: Packed in containers, labeled clearly with part number, designating contents, and pieces of equipment.

1.7 WARRANTIES AND BONDS

A. All equipment supplied under this section shall be warranted by the Contractor for a minimum of one (1) year from the date of equipment start-up or from the date of Engineer's acceptance of the equipment for permanent operation, whichever is later.

B. The equipment shall be warranted by the manufacturer free from defects in workmanship, design and materials. If any part of the equipment should fail during the warranty period, it shall be replaced at no expense to the Owner.

C. Manufacturer's Certificate: The system supplier will submit to the Engineer and Owner, a written report certifying that the equipment has been satisfactorily installed.

1.8 START-UP AND TRAINING SERVICES

A. Manufacturer shall include a minimum of one (1) five-day trip, exclusive of travel time, for the purpose of supervising installation, start-up and instruction of Owner's personnel in proper operation and maintenance.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Minimum services to be provided by manufacturer's factory representative while on site:
   1. Observe, inspect and approve installation – 3 days.
   2. Start-up and Commissioning – 1 day.
   3. On-site training and O&M – 1 day.

1.9 OPERATION AND MAINTENANCE MANUALS

A. Provide operation and maintenance manuals to Owner under the provisions of Division 01 Section "Operation and Maintenance Data".

PART 2 - PRODUCTS

2.1 GENERAL

A. The nitrogen system shall be supplied for fire suppression at three independent locations. System supplier to provide bulk nitrogen tank and all controls, connections, and appurtenances for complete nitrogen blanket system.

B. Foundation system for nitrogen tank and appurtenances to be designed by a professional engineer licensed in the State of Kentucky. Concrete design shall be in accordance with ACI 318 (latest edition) "Building Code Requirements for Reinforced Concrete".

C. Nitrogen Locations:
   1. Silos: Gas will be fed into the lower cone portion of each silo at 71 scfh with an adjustable nitrogen regulator with a maximum allowable pressure of 35 psig. Each silo shall have a minimum of two (2) connection points spaced 180 degrees apart.
   2. Dryer: The Nitrogen to the dryer will be utilized on start-up, shutdown, and in case of high temperatures. Start-up, shutdown, and an emergency high temperature require an intermittent flow of 30 scfm each. The dryer has a 3/4" NPT solenoid valve controlled by the dryer PLC. The consumption will be a minimum of two (2) volume exchanges on start-up and two (2) volume exchanges on shutdown. The Nitrogen line will require a regulator to bring the pressure below 35 psig and will also require a rotometer to regulate the flow between 0-1800 scfh. Volume exchange is approximately 750 cf so each start-up and shutdown will consume approximately 1,500 cf of Nitrogen.
   3. Expansion Tank: Nitrogen gas padding at the thermal oil expansion tank will require a nitrogen regulator with a max allowable nitrogen supply pressure of 15 psi. The flow is estimated at 5 scfm intermittent.

2.2 ACCEPTABLE MANUFACTURERS

A. Chart, Inc.

B. Or approved equal.

2.3 SYSTEM COMPONENTS

A. The system shall consist of: one (1) VS-1500SC-250-CS-01 (or approved equal) – vertical 1500 gallon nitrogen tank; 250 PSI MAWP; Dual relief valves and rupture discs; Top and Bottom Fill circuit with CGA LIN Fill Fitting; Full Trycock; and Pressure building circuit with economizer circuit, and liquid to vaporizer.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. The system will also consist of the following components:
   1. Standard 2-part Hentzen paint system;
   2. One (1) Tank Mounted 2000 scfh Vaporizer;
   3. All bronze/brass piping components with Type 304 welded stainless steel interconnecting pipe/tube;
   4. One (1) Main Pressure Control Skid including:
      a. One (1) Analog Pressure Indicator and transmitter (4 – 20 mA);
      b. One (1) 1/2" Inlet check valve;
      c. Two (2) 1/2" Rego BR-1784B mechanical regulators, 40-110 PSI range (or approved equal);
      d. Four (4) Regulator Isolation ball valves; and
      e. One (1) Lot relief valves as required.
   5. One (1) Nitrogen Dryer regulation manifold including:
      a. One (1) Analog Pressure Indicator;
      b. One (1) 1/2" Inlet check valve;
      c. One (1) 1/2" Rego BR-1784A mechanical regulator, 5-55 PSI range (or approved equal);
      d. One (1) Regulator Isolation ball valve; and
      e. One (1) Dwyer Rotometer, 0-1800 scf (or approved equal).
   6. Two (2) aluminum piping stands; and
   7. Level element and transmitter (4 – 20 mA).

C. Contractor shall install all piping, wall penetrations, pipe hangers and supports, valves, regulators and safety components as directed by the system supplier. Install the nitrogen storage tank on the concrete pad provided with 316 SS anchor bolts as directed by the equipment supplier. Provide a gas filling connection at the Biosolids Dryer Building driveway near the tank with a gas fill connection as recommended by the tank equipment supplier.

D. At the nitrogen feed points solenoid valves shall be provided to open and close the gas supply. See the Loop Descriptions, Division 40 9600 for operational descriptions.

2.4 ELECTRICAL / CONTROL SYSTEM

A. Electrical and Control System must comply with Division 26 and Division 40 specification sections.

B. Communication between the main control panel and the Biosolids Storage System panel will be by Ethernet. A single-point power supply to the equipment will be 480 volts, 60 Hz, 3-phase and will operate all system components.

C. System supplier shall coordinate with Biosolids System Supplier to assure compatibility for all controls for the nitrogen storage and distribution system will be from Control Panel BSS-7040. Any modifications shall be borne by the nitrogen system supplier.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 3 - EXECUTION

3.1 TESTING

A. System supplier shall furnish all liquid nitrogen for system test. All piping shall be tested for leaks.

3.2 INSTALLATION

A. Contractor shall install the equipment and all appurtenances in accordance with manufacturer's recommendations.

3.3 INSPECTION

A. Inspect the nitrogen storage and distribution system for shipping damage and to ensure that all accessories arrived undamaged and are in conformance with the specifications.

B. Check all electrical system components for proper connections.

C. Touch up factory coating as required.

3.4 COMMISSIONING

A. Start-up and commission the nitrogen gas system under the provisions of Division 01 Section "Start-up Procedures".

B. Provide system demonstrations and furnish instructions to Owner's personnel under the provisions of Division 01 Section "Demonstration and Training".

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Related Sections include the following:
1. Division 01 Section “Submittal Procedures”.
2. Division 01 Section “Quality Requirements”.
3. Division 01 Section “Start-up Procedures”.
4. Division 01 Section “Operation and Maintenance Data”.
5. Division 01 Section “Demonstration and Training”.
6. Division 26 Section “Variable-Frequency Motor Controllers”.
7. Division 40 Section "Instrumentation and Control Components".
8. Division 40 Section "Package Control Systems.
9. Division 44 Section “Wet Cake Hopper”.
10. Division 44 Section “Indirect Dryer System”.

1.2 SUMMARY

A. This Section includes two progressive cavity pumps that feed the indirect dryer system. Pumps shall be furnished and installed with motor, reducer, VFD, control panel with PLC and Panelview HMI, slip ring, booster pump, air compressor, and all appurtenances required for a complete system. The equipment and all appurtenances will be installed as recommended by the manufacturer, and in compliance with all OSHA, local, state and federal codes and regulations.

B. Pump shall be designed for use in wastewater applications with 15 – 18% solids and be of heavy-duty, high-efficiency design with a minimum service life of 20 years. Pump and associated equipment shall be suitable for the specified application and shall conform to this specification.

C. All equipment included in this Section shall be furnished by a single supplier who shall be responsible for design, coordination, and satisfactory operation of the system. Any re-design required to accommodate an approved equal proposal or alternative model(s) other than those specified in this Section shall be borne by the system supplier.

1.3 DEFINITIONS / STANDARDS

A. American Gear Manufacturing Association (AGMA).

B. American Institute of Steel Construction (AISC).

C. American Iron and Steel Institute (AISI).

D. American National Standards Institute (ANSI).

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

E. American Society for Testing and Materials (ASTM).

F. Hydraulic Institute (HI).

G. National Electric Code (NEC).

H. National Electrical Manufacturers Association (NEMA).

I. Occupational Safety and Health Administration (OSHA).

1.4 SUBMITTALS

A. For approval, the pump manufacturers shall submit the following:
1. Certified pump outline drawings.
2. Typical cross sectional drawings for both pumps and air compressor.
3. Factory-certified characteristic curves of pump performance, NPSHR, power requirements, and efficiency for both the progressive cavity pump and booster pump.
4. Performance, power, and efficiency of air compressor.
5. Operation and maintenance manual as specified in Division 01, Section "Operation and Maintenance Data".
6. Wiring Diagrams.
7. Materials of Construction.
8. Equipment weight.
9. Motor data for all system components.
10. A copy of this specification section with addenda updates, and all referenced sections to show specification compliance or marked to show deviations.

B. Number of Submittals: As specified in Division 01, Section "Submittal Procedures".

C. At the time of submission, the manufacturer shall, in writing, call the Owner's and Engineer's attention to any deviations that the submittal may have from the requirements of these Specifications.

D. All materials submitted for review shall be contained in one submission. Partial submittals will not be reviewed. Sales bulletins or other general publications are not acceptable for review, except where necessary to provide supplemental technical data.

E. Performance affidavit.

F. A complete written description of the warranty to be provided.

1.5 QUALITY ASSURANCE

A. The progressive cavity pumps shall be the product of a recognized manufacturer whose personnel have been regularly engaged in the design and manufacturing of such equipment. The manufacturer must be able to demonstrate experience with the design, fabrication, supply, and successful operation of progressive cavity pumps of similar size and capacity. The manufacturer/supplier shall demonstrate upon the request of the Engineer that:

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1. They maintain a reasonable stock of spare parts for this equipment.
2. They employ sufficient qualified technical personnel to insure adequate servicing and operational control advice.

B. Provide a list of references (name, location and contact information) of at least three installations that have been in full operation for 5 years using the same or similar model proposed located in the United States.

C. Pumps supplied shall conform to this specification and the Hydraulic Institute, Latest Edition. The pump manufacturer shall supply a certificate of conformance at time of shipment, to be included with shipment to confirm that pumps supplied are to these specifications.

D. Factory Test:
1. Pump manufacturer to provide certified performance testing on progressive cavity pumps. Engineer may witness all or part of the performance testing if desired. Manufacturer shall pay all witness testing expenses for a minimum of two people (one representative from Owner and Engineer).
2. If the certified factory testing indicates noncompliance with the requirements of this specification, the progressive cavity pumps shall be re-worked and re-tested at the manufacturer's expense until compliance with the specification is attained.

E. All parts of the equipment provided to be designed and manufactured for long, continuous and uninterrupted service. All materials used to be of best quality and entirely suitable for service required.

F. Identification: The specified system shall be identified with a corrosion-resistant nameplate, securely affixed in a conspicuous location. Nameplate information shall include equipment model number, serial number, and supplier's name and location.

1.6 DELIVERY, STORAGE AND HANDLING

A. Ship items as complete assemblies except where partial disassembly is required by transportation regulations or for protection of components. Pumps and related equipment shall ship F.O.B. to the Project site. All claims relating to short shipments or damaged equipment must be filled within two (2) working days after receipt of equipment with the freight line.

B. Protect equipment during storage and shipment in accordance with the manufacturer's recommendations.

C. At the Contractor's expense, the pumps and related equipment shall be unloaded and stored in strict accordance with the manufacturer's requirements until installed and accepted by the Owner for beneficial use. Prior to storage, the Contractor shall review in detail items relating to mounting, lubrication, alignment, power requirements and rotation as specified by the manufacturer to insure proper warranty.

D. Spare Parts: Packed in containers, labeled clearly with part number, designating contents, and pieces of equipment.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1.7 WARRANTIES AND BONDS

A. All equipment supplied under this section shall be warranted by the Contractor for a minimum of one (1) year from the date of equipment start-up or from the date of Engineer's acceptance of the equipment for permanent operation, whichever is later.

B. The equipment shall be warranted by the manufacturer free from defects in workmanship, design and materials. If any part of the equipment should fail during the warranty period, it shall be replaced at no expense to the Owner.

C. Manufacturer's Certificate: The progressive cavity pump manufacturer will submit to the Engineer and Owner, a written report certifying that the equipment has been satisfactorily installed.

1.8 START-UP AND TRAINING SERVICES

A. Pump manufacturer shall include a minimum of two (2) three-day trips, exclusive of travel time, for the purpose of supervising pump installation, start-up and instruction of Owner's personnel in proper operation and maintenance.

B. Minimum services to be provided by pump manufacturer's factory representative while on site:
   1. Observe, inspect and approve installation – 1 day.
   2. Supervise initial adjustment – 1 day.
   3. Supervise field run test – 2 days.
   4. Instruct Owner in proper start-up and O&M – 2 days.

PART 2 - PRODUCTS

2.1 GENERAL

A. The pumps shall be heavy-duty, positive displacement, progressive cavity type with a gear or pin joint drive train. Drive train shall be firmly supported by heavy duty bearings integral to the pump. Gear reducer shall be sized for a minimum service factor of 1.5 and designed with a thrust load capability of 150 percent of the actual thrust load. The pumps, along with associated drive appurtenances, shall be mounted on common fabricated steel baseplates.

B. All equipment shall be designed and built for 24-hour continuous service without overheating, cavitation, or excessive vibration.

C. Pumps shall be furnished and installed as a unit including but not limited to the following:
   1. Two (2) variable frequency drives;
   2. Two (2) discharge pressure sensors;
   3. Two (2) slip rings;
   4. One (1) booster pump;
   5. Two (2) sets of load cells;
   6. One (1) air compressor;

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

7. Two (2) coupling and OSHA approved guards;
8. Two (2) in-line foot mounted Class II C-face gear reducers;
9. Two (2) transitional neoprene flanged connections from pump's hopper to live bottom on wet cake hopper; and
10. One (1) control panel with PLC and PanelView HMI.

D. All lubrication fittings shall be brought to the outside of the equipment so that they are readily accessible from the outside without the necessity of removing covers, plates, housing or guards.

2.2 ACCEPTABLE MANUFACTURERS

A. Moyno 2000 Pump Model 4H065G2R10 CDQ5AAA, of Springfield, OH.

B. Seepex Series BTHE Model 35-24, of Enon, OH.

C. Or approved equal.

2.3 PERFORMANCE REQUIREMENTS

A. The progressive cavity pumps pump the dewatered sludge from the wet cake hoppers and discharge into the dryer system or out to a truck. The pumps are located in a pump pit with limited height and width restrictions. If pump and all appurtenances for complete and operable system are unable to fit in the required space, re-design fees will be borne by system supplier.

B. Pump Data:

1.	Type:	Progressive Cavity
2.	Number Required:	2
3.	Sludge Cake (%):	15 – 18
4.	Capacity:	
	a. Condition 1:	20 gpm @ 150 psi
	b. Condition 2:	40 gpm @ 200 psi
5.	Min. No. of Stages:	4
6.	Max. RPM:	80
7.	Inlet Hopper Size:	1 meter
8.	Discharge Size (in):	10
9.	Max. Pump Width (ft):	2
10.	Max. Pump Length (ft):	12

C. Motor Data:

1.	Rated Horsepower:	40
2.	RPM:	1750
3.	Voltage:	480
4.	Hz:	60
5.	Phase:	3

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2.4 MATERIALS OF CONSTRUCTION

A. Body:
1. A 250 pound (ANSI B16.5) RF flanged connection shall be provided at the discharge port. The discharge casings shall each be provided with a 3/8-inch (or larger) tap to permit installation of pressure instruments. The suction casing shall be fabricated from corrosion resistant steel plate and designed with a rectangular opening which is 1 meter long.
2. System supplier to provide 304 stainless steel transition piece between progressive cavity pump and wet cake hopper's live bottom. Transition piece to use flanged neoprene connection. System supplier to coordinate transition piece between pump hopper and live bottom with wet cake hopper manufacturer.
3. A single helix auger shall run the entire length of the suction casing and the extension tube. The auger shall be driven by the main pump drive gear motor. The auger and extension tube work in concert to apply additional shearing forces against the sludge to reduce the apparent viscosity of the material, minimize air entrainment and improve the volumetric efficiency of the pumping elements. The walls of the hopper shall be vertical to minimize bridging.

B. Rotor and Stator:
1. Each pump shall be a minimum 4 stage design employing a convoluted rotor operating in a similarly convoluted stator. The convolutions shall be configured to form a cavity between the rotor and stator, which shall progress from the pump's inlet to discharge port with the operation of the rotor.
2. The fit between the rotor and stator at the point of contact shall compress the stator material sufficiently to form a seal and to prevent leakage from the discharge back to the inlet end of the pumping chamber.
3. The pump rotor shall be one-piece construction with integrally machined rotor head. Rotor shall be machined from alloy steel with chromium coating using the Duktil method or hard chrome plating with a thickness of 0.010-inches.
4. The stator shall be molded with a seal integral to the stator elastomer preventing the metal stator tube and the bonding agent from the elastomer from contacting the pumped liquid.
5. Stators shall have Buna or Therban elastomer.
6. The stator shall be rigidly fastened to the suction housing and discharge flange with removable clamp rings or tie rods to facilitate stator removal.

C. Drive Shaft:
1. Drive shall consist of grease lubricated, totally enclosed sealed and shielded, crowned gear or pin type. The universal joint shall be totally enclosed and protected by a wire reinforced elastomeric seal. Mechanical components of the universal joints shall be designed to operate for 10,000 hours at the manufacturer's published maximum speeds and pressures.
2. Joints utilized in the progressive cavity pump must have separate components handling the thrust forces and rotational forces.
3. Drive shaft design shall permit quick disassembly of the universal joints without affecting the alignment and setting of the pump bearings.
4. Carbon steel shafts shall be coated with hard chrome plating with a nominal chrome plate thickness of 0.010-inches for maximum abrasion resistance, to prevent scouring of the shaft in the packing area. Progressive cavity designs that do not protect the drive shaft from abrasive wear with chrome plating will not be accepted.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

D. Connecting Rod:
   1. The connecting rod shall connect the universal joints of the drive shaft and eccentrically moving rotor.
   2. The connecting rod shall be machined of alloy steel. The alloy steel shall be ASTM 331-90, grade A8620. Total angularity of the connecting rod shall not exceed 1.5 degrees.

E. Stuffing Box:
   1. The stuffing box shall be equipped with a ductile iron gland, split 316 stainless steel lantern ring and shall be suitable for grease lubrication.
   2. The construction shall be such that the gland may be adjusted or the pump repacked without dismantling any other part of the pump.

2.5 SLIP RING AND BOOSTER PUMP

A. System supplier shall furnish one non-potable water lubrication ring per pump (total of two). Slip ring shall have 10-inch flanged connections to be connected to 10-inch discharge piping. Slip ring shall be located on the discharge side of pump as shown on the drawings.

B. System supplier is to furnish one booster pump to be used with the slip ring. Plant water will be provided at 0.2 gpm at 100 psi. Pump manufacturer is responsible for sizing and providing appropriate booster pump. Booster pump shall be located on the east wall of the pump area as shown on the drawings.
   1. Booster pump to have 1/2-inch discharge size and 1-inch suction size.
   2. Maximum pump horsepower shall be 1/2 HP.
   3. Acceptable Manufacturers:
      a. Moyno.
      b. Seepex Model MD.
      c. Or approved equal.

C. Lubrication ring shall be made of 316 stainless steel and machined on the inside diameter such that a notched area for the non-potable water injection points are protected from the sludge cake flow on the upstream side with a 1/4-inch lip. The inside diameter of the ring on the downstream side of the injection points shall be beveled at a 45 degree angle so that a smooth flow, of non-potable water from the injection points, into the piping is insured.

D. The ring shall be a minimum 1-1/2" in thickness and drilled to fit between two 10-inch ANSI pipe flanges as shown in the plans.

E. The ring shall have a minimum of 3 equally spaced injection points at 1/4-inch NPT minimum, and shall include all necessary fittings and tubing to be manifolded into injection points with a minimum 1/2-inch NPT connection.

F. A rotometer shall be provided in each discharge line to the slip ring. The rotometer shall adjust the flow rate to each ring between 0 - 1 gpm.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2.6 AIR COMPRESSOR

A. System supplier is to furnish one (1) portable air compressor to be used for flushing wet cake from pipe lines as shown on the drawings.

B. Air compressor to be a minimum of 5 cfm @ 200 psi.

C. Voltage to be 120, with 15 amps AC and 1.9 Hp. Tank to be 15 gallons with 1750 rpm motor.

D. System supplier to furnish ASME code tank with pressure regulator and two pressure gauges.

E. Acceptable Manufacturer:
   1. Grainger.
   2. Or approved equal.

2.7 LOAD CELLS

A. The load cells shall continually monitor and control the sludge level in each of the 1 meter pump hoppers. System supplier to furnish a closed loop level control system.

B. One load cell weighing assembly per pump shall be provided. Each weighing assembly shall consist of a nickel plated load cell of the shear beam strain gauge type and all appropriate mounting hardware.

C. A flexible cable shall connect each load cell to the indicators for easy remote installation of the readout. Cable lengths shall be a minimum of 20 feet.

D. Pump weighing assemblies shall be self-checking and have provisions for thermal expansion and contraction. Pump weighing assembly load plate shall be able to compensate for mounting surfaces up to 4 degrees off-level.

E. A remote mounted 4-1/2 digit LCD indicator shall be housed in a NEMA 4X, UL approved enclosure. LCD Indicator shall be backlit with 0.5" characters for ease of readability in low light conditions.

F. To allow indication of net weight, indicator shall be equipped with a sealed ten turn knob for tare adjustment. Indicator shall output net weight via a 4-20mA signal for remote monitoring. Indicator shall have two adjustable set points for alarms or liquid level control.

G. Approved Manufacturers:
   1. Force Flow of Concord, CA.
   2. Or approved equal.

2.8 MOTOR AND VFD

A. Motors:
   1. Motors shall be factory-mounted, direct connected to the equipment driven, or to its speed reducing device.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2. Motors shall be energy-efficient, totally enclosed fan-cooled (TEFC) design.
3. All motors shall be alternating current squirrel-cage induction type motors, designed to withstand full voltage starting.
4. Locked-rotor torques, breakdown torques, and locked-rotor currents shall be in accordance with NEMA standards, and shall be suitable for the service intended.
5. All motors shall have minimum NEMA Class B insulation and shall be designed to operate continuously in a 40 degree C. ambient temperature without exceeding a NEMA Class B temperature rise.
6. Bearings:
    a. Guide and thrust bearings shall be sleeve or ball type sealed against dust and escape of lubricant.
    b. Bearings shall be oil or grease lubricated.
    c. Thrust bearings shall be capable of sustaining the weight of the equipment and the dynamic load imposed upon them where required by installation.
    d. Pump motor bearings shall be suitable for pump operation at shut-off head.
    e. Bearings are to be designed for a minimum B-10 life of 100,000 hours under maximum operating conditions and will not require periodic lubrication.

B. Variable-Frequency Drive:
1. VFDs shall comply with Division 26, Section “Variable-Frequency Motor Controllers”.
2. The VFDs for each pump shall be a positive hydraulic drive designed to transmit constant output torque at all output speeds. The drive shall be an integral unit mounted on a common base plate with the pump.
3. The internal mechanism shall be housed in one compact, dustproof, fan-cooled casing which shall also form the oil reservoir.
4. The speed control dial shall be mounted on the side of the drive unit and shall allow smooth, stepless speed changes without stopping the pump. The speed control system shall maintain the speed setting without drifting from more than 5 percent of the actual speed setting. The speed control shall be manual adjustable and shall be designed for electronic control.
5. All harmonic requirements listed in Division 26 Section "Variable-Frequency Motor Controllers" shall be met. Any modifications for harmonic related issues shall be borne by the pump supplier.

2.9 CONTROL SYSTEM

A. System supplier is to furnish one (1) control panel with VFDs, PLC, PanelView HMI, and all necessary controls for a complete and operable system. The Dryer Building has ventilation only and worse case summer condition is 104 degrees F. If panel cannot handle that temperature a refrigerant circuit or air conditioner shall be required in panel by system supplier.

B. Run dry protection: The stator shall be fitted with a sensor sleeve and thermistor sensor. A controller shall also be provided in the control panel. The controller shall monitor the stator temperature and activate a shutdown and alarm sequence if the stator temperature reaches the adjustable limit on the controller. The controller shall include a manual local and remote reset function. Input to the controller shall be 120 VAC / 60 Hz.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

C. Control Panel and PLC (BSPCP-7020):
   1. Control panel shall be provided with Allen Bradley Control Logix PLC with PanelView (or approved equal) as specified in Division 40 Section "Programmable Logic Process Controllers".
   2. Control panel shall be NEMA 4X stainless steel enclosure with hinged door.
   3. Control panel shall be furnished as a fully functional system with single point electrical power connection to operate all system components.
   4. Load Cells:
      a. Switch “Hand-Off-Automatic”: In the hand mode, manual operation is chosen. The load cell control system is bypassed. In the automatic mode the system operates in a closed loop control with the load cell control system.
      b. Switch “Main Disconnect”: The control is connected to become voltage-free via the main disconnect switch.
   5. The following messages shall be displayed on the integrated control panel.
      a. Control "On": A lamp indicates that the control was switched on.
      b. Status messages of the weight metering: A lamp shall indicate high weight in the pump hopper. This message is additionally transmitted as a potential-free relay message at the terminal strip. This relay shall connect to the controller responsible for filling the pump hopper and shut it down to prevent hopper overflow.
      c. Error warning "Dry Running": Dry-running of the pump shall be indicated locally by a lamp. The message is activated once a stator temperature of 50 °C is reached. The trip shall be factory set at 50 °C but shall be field adjustable. This disconnection temperature can be adjusted at the TSE controller. This message is additionally transmitted as a potential-free relay message at the terminal strip. This relay shall connect to the integral VFD responsible for driving the pump and shut it down to prevent stator damage.
      d. Error warning "High Discharge Pressure": Dead heading or high discharge pressure shall be indicated locally by a lamp. The message is activated once a discharge pressure of 300psi is reached. This disconnection pressure can be adjusted at the pressure switch. This message is additionally transmitted as a potential-free relay message at the terminal strip. This relay shall connect to the integral VFD responsible for driving the pump and shut it down to prevent damage.
   6. The contractor is responsible for all wiring and hardware mounting.
   7. The following status signals shall be available on a termination strip for connection to the plant SCADA system:
      a. Pump motor running (dry contact closure).
      b. Remote/local selector position (contact closed when in remote position).
      c. Pump Speed (isolated 4-20 mA DC).
      d. Booster pump motor running.
      e. Load cells hand/off/auto.
      f. Air compressor hand/off/auto.
   8. The following control signals shall be interfaced to the control circuitry for computer control, each brought out to a termination strip:
      a. Momentary pump start (dry contact closure).
      b. Momentary pump stop (dry contact closure)
      c. Increased Speed (dry contact – closed to increase speed).
      d. Decrease Speed (dry contact – closed to decrease speed).

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2.10 PUMP STATUS

A. For pumps greater than 15 hp and less than 50 hp, the pump system shall monitor and report voltage, amps, kW-hrs, phase fault, and winding temperature fault.

B. For pumps greater than 50 hp, the pump system shall monitor and report voltage, amps, kW-hrs, phase fault, winding temperature, vibration, and bearing temperature.

C. All package pumps shall be supplied with local readout and Ethernet connections for outputs.

2.11 PRESSURE GAUGES

A. Provide a pressure gauge on the discharge of each pump. Pressure gauge shall comply with Division 40 Section "Instrumentation and Control Components.

B. Gauge shall consist of the primary element and a transmitter to the cake control panel. An adjustable high pressure alarm will be indicated on the control panel. Gauge scales shall be compatible with the head conditions specified.

2.12 PAINTING, COATING AND SURFACE PREPARATION

A. Painting shall comply with Division 09 Section "Protective Coatings".

B. Surface Preparation (at a minimum):
   1. Solvent cleaning – Remove all oil, grease, dirt and other contaminates by solvent cleaning with Varsol, Acetone or approved equal.
   2. Hand and power tool cleaning – Remove all loose rust, scale, metal chips, weld splatter and other foreign material by one or more of the following methods:
      a. Power tools.
      b. Hand chipping.
      c. Scraping.
      d. Wire brushing.
      e. Blast cleaning to SSPC-SP6.
   3. Surface irregularities – Small surface pits or irregularities are smoothed using Devcon A plastic steel or approve equal.

C. Paint Application (at a minimum):
   1. Paint shall be applied using standard spraying equipment or brushing as necessary.
   2. Air temperature and equipment temperature shall be at least 50 degrees F prior to the paint application.

D. The pump manufacturer shall specially handle all painted components and complete assembled pumps to insure that the applied surfaces are not damaged prior to shipment. The preparation for shipment of applied surfaces shall be taken into consideration when units are skidded for shipping, making all efforts to protect the surfaces from damage.

2.13 SPARE PARTS

A. The manufacturer shall furnish the following set of spare parts:

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1. One (1) Set Packing
2. One (1) Grease Seal
3. One (1) O-Ring Kit

PART 3 - EXECUTION

3.1 TESTING

A. All performance testing shall be completed prior to the application of any "FINAL" paint and/or coating. All factory testing shall be in accordance with the standards of the Hydraulic Institute, Latest Edition. All testing is to be performed at the pump manufacturer's facility.

B. All witness test results shall be submitted with the Submittal Package. Pump shall not be shipped prior to final approval of the Submittal Package by the Engineer.

C. Performance testing shall be witnessed with the customer's motor. The test shall include head, capacity and power readings at four (4) points including the rated point, to determine the actual pump performance and efficiency. Testing of the fully assembled pump with customer motor shall establish that the complete pump system is free of overheating, cavitation and excessive vibration over the specified conditions. A certified performance curve shall be completed after the test and included in the final data package. The certified test data plot shall define pump performance at various speeds, power requirements, and efficiency and shall be sealed by a registered Professional Engineer licensed in the State of Kentucky.

D. A minimum of ten (10) days notice shall be given to the Engineer prior to the start of any witness testing.

E. At the Project site, field/functional testing will be performed to insure proper mechanical operation and the pumps will meet the specified operating conditions. Perform all field testing in the presence of an Engineer.

F. Motor tests and test reports shall be provided.

G. System supplier shall include all expenses for travel, food, and lodging for all witness testing in the price of the pumping system for two Owner Representatives.

H. Make repairs and retest pumps and motors until specified capacities, and operating characteristics limits are achieved.

I. System supplier is to provide labor, piping, equipment, and materials necessary for conducting tests.

3.2 INSTALLATION

A. Install pumps in accordance with manufacturer's instructions.

B. Apply finish paint system under the provisions of Division 09 Section "Protective Coatings".

C. Provide for connection of motors to electrical service.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

D. Lubricate pumps before start-up.

E. Support suction and discharge piping to prevent excessive dead and live loads from being imposed on pump casings.

F. Align couplings to pump manufacturer's specifications. Realign couplings as required to meet specified vibration limits. Owner may, at his option and expense, periodically check coupling alignment during the Correction Period of each pump.

3.3 COMMISSIONING

A. Start-up and commission pumps and motors under the provisions of Division 01 Section "Start-up Procedures".

B. Perform pumping system demonstrations and furnish instructions to Owner's personnel under the provisions of Division 01 Section "Demonstration and Training".

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Related Sections include the following:
1. Division 01 Section “Submittal Procedures”.
2. Division 01 Section “Quality Requirements”.
3. Division 01 Section "Start-Up Procedures".
4. Division 01 Section “Operation and Maintenance Data”.
5. Division 01 Section "Demonstration and Training".
6. Division 26 Section “Variable-Frequency Motor Controllers”.
7. Division 40 Section "Packaged Control Systems".
8. Division 40 Section "Instrumentation and Control Components".
9. Division 44 Section “Progressive Cavity Pumps”.

1.2 SUMMARY

A. This section describes the wet cake hopper with live bottom that stores the dewatered sludge discharged from the centrifuge’s conveyor system prior to being fed into a progressive cavity pump. The system supplier shall furnish a complete system including, but not limited to, two 100 yd^3 hoppers, mounting and support frames, load cells, level sensors, live bottoms (with twin reversing screw conveyors), VFDs for the live bottom screws, discharge chutes, discharge slide gates, motor reducers, electrical controls, control panel, platforms and access ladder, safety accessories and all appurtenances specified or required for a complete and operable system. The equipment and all appurtenances will be installed as shown on the plans, as recommended by the Manufacturer, and in compliance with all OSHA, local, state and federal codes and regulation.

B. All equipment included in this section shall be furnished by a single supplier who shall be responsible for the design, coordination, and satisfactory operation of the system. Any re-design required to accommodate the Owner for an approved equal proposal shall be borne by the system supplier.

1.3 DEFINITIONS / STANDARDS

A. American Gear Manufacturers Association (AGMA).

B. American Iron and Steel Institute (AISI).

C. American Society for Testing and Materials (ASTM).

D. National Electrical Code (NEC).

E. National Electrical Manufacturers Association (NEMA).

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

F. Totally Enclosed, Fan Cooled (TEFC).

G. Variable Frequency Drive (VFD).

1.4 SUBMITTALS

A. Product Data: Complete engineering data including, but not limited to, descriptive data, material specifications, performance data, and wiring diagrams. Differentiate between manufacturer-installed and field-installed wiring.

B. The following shall be included as a minimum in the shop drawings:
1. Certified process mechanical drawing with general arrangement showing principal dimensions and weights of the wet cake hopper and live bottom twin screw conveyors.
2. Descriptive literature regarding the conveying equipment to be supplied.
3. General arrangement drawings for the proposed equipment.
4. All dimensional drawings necessary to coordinate with structural, architectural, and other disciplines.
5. Cut sheets for electric motors and ancillary items.
6. Performance of the screw conveyors when operating at full load to confirm compliance with power input and capacity requirements.
7. Conveyor torque requirement calculations.
8. Torque calculations for the gear reducers and reducer motors.
9. Horsepower calculations for the drive motors.
10. Complete schematic diagrams for electrical control panel.
11. Electrical single line diagram showing all power requirements.
12. Drawings of control panel including door layout, interior layout, electrical ladder diagram, interconnects to all components outside of panel, and structural and mounting details.
13. Drawings of platforms showing dimensions and weights.
14. Installation instructions including leveling, alignment, pre-start-up checklist and initial start-up procedures.
15. Proposed surface preparation and factory paint.
16. Materials of Construction for all major components and accessories.
17. A copy of this Specification Section with Addenda updates and all referenced Sections to show Specification compliance or marked to show deviations.

C. Number of Submittals: As specified in Division 01, Section “Submittal Procedures”.

D. At the time of submission, the manufacturer shall, in writing, call the Owner’s and Engineer’s attention to any deviations that the submittal may have from the requirements of these Specifications.

E. All materials submitted for review shall be contained in one submission. Partial submittals will not be reviewed. Sales bulletins or other general publications are not acceptable for review, except where necessary to provide supplemental technical data.

F. Performance affidavit.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

G. A complete written description of the warranty to be provided.

H. Operation and Maintenance Data shall be as specified in Division 01 Section "Operation and Maintenance Data".

1.5 QUALITY ASSURANCE

A. The wet cake hopper shall be the product of a recognized manufacturer whose personnel have been regularly engaged in the design and manufacturing of such equipment. The manufacturer must be able to demonstrate experience with the design, fabrication, supply, and successful operation of a wet cake hopper of similar size and capacity. The manufacturer/supplier shall demonstrate upon the request of the Engineer that:
   1. They maintain a reasonable stock of spare parts for this equipment.
   2. They employ sufficient qualified technical personnel to insure adequate servicing and operational control advice.

B. Manufacturer shall have a quality assurance and control system to ISO9001 or equivalent. Equivalence to be demonstrated through submission of a Quality Plan which details all aspects of the company operation. The Quality Plan to be submitted within 10 days of receipt of a Purchase Order. Acceptance of the Quality Plan shall be at the sole discretion of the Engineer.

C. Provide a list of references (name, location and contact information) of at least three installations that have been in full operation using the same or similar model proposed located in the United States.

D. Factory Test:
   1. Manufacturer to provide certified performance testing on live bottoms as outlined in this specification. Engineer may witness all or part of the performance testing if desired. Manufacturer shall pay all witness testing expenses for a minimum of two people (one representative from Owner and Engineer).
   2. If the certified factory testing indicates noncompliance with the requirements of this specification, the live bottom shall be re-worked and retested at the manufacturer's expense until compliance with the specification is attained.

E. All parts of the equipment provided to be designed and manufactured for long, continuous and uninterrupted service. All materials used to be of best quality and entirely suitable for service required.

F. Identification: The specified system shall be identified with a corrosion-resistant nameplate, securely affixed in a conspicuous location. Nameplate information shall include equipment model number, serial number, and supplier's name and location.

1.6 DELIVERY, STORAGE AND HANDLING

A. Ship items as complete assemblies except where partial disassembly is required by transportation regulations or for protection of components.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Protect equipment during storage and shipment in accordance with the manufacturer's recommendations.

C. Spare Parts: Packed in containers, labeled clearly with part number, designating contents, and pieces of equipment.

1.7 WARRANTIES AND BONDS

A. All equipment supplied under this section shall be warranted by the Contractor for a minimum of one (1) year from the date of equipment start-up or from the date of Engineer's acceptance of the equipment for permanent operation, whichever is later.

B. The equipment shall be warranted by the manufacturer free from defects in workmanship, design and materials. If any part of the equipment should fail during the warranty period, it shall be replaced at no expense to the Owner.

C. Manufacturer's Certificate: The wet cake hopper manufacturer will submit to the Engineer and Owner, a written report certifying that the equipment has been satisfactorily installed.

PART 2 - PRODUCTS

2.1 GENERAL

A. The wet cake hopper will be located inside the Biosolids Dryer Building and will be used to receive and store dewatered sludge from three conveyors (provided in Contract 2) located in the Sludge Processing Building. In the Sludge Processing Building, three centrifuges (provided in Contract 2) discharge into the inclined conveyors. The three conveyors each have two slide gates (provided in Contract 2) for discharging the dewatered sludge into either of the wet cake hoppers.

B. Each wet cake hopper will have twin discharge screws that feed the wet cake into a progressive cavity pump. Any costs for deviations from what is specified in this Section shall be borne by the equipment supplier.

C. Wet cake hopper will be monitored using load cells and level sensors. Load cells will be placed under each support to monitor the level of wet cake in the hopper. Wet cake hopper to be designed with six support legs. Any deviation from this design that results in structural re-design shall be borne by the equipment manufacturer. Level sensors will be located between the three conveyors to monitor the sludge height in each hopper.

D. Two 4-inch Class 150 flanged connections shall be provided at the bottom of each shaftless screw to drain the hopper during maintenance activities. System supplier shall provide drain connections with all required appurtenances for operation.

E. Live bottoms shall be designed to operate without sludge bridging, clogging, packing, sticking, or otherwise reducing ability to feed the progressive cavity pump.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

F. Wet cake hopper with live bottom, support frame, and platforms shall be designed by a licensed Professional Engineer licensed in the State of Kentucky. Design shall consider hopper full of dewatered sludge. Platforms shall be designed for all dynamic loads. Calculations shall be included with submittal.

G. Fabricate and assemble all equipment under this section in full conformity with this specification and as shown in the contract drawings.

H. System supplier shall furnish equipment complete with all supports, platforms, and mechanical equipment required for proper operation, including complete drive units, steel and other metal construction specified herein, and all additional materials or fabrication as required by the supplier's design.

2.2 ACCEPTABLE MANUFACTURERS

A. BioSec Enviro Inc., of Milton, Ontario

B. Jim Myers & Sons, Inc., of Charlotte, NC

C. KWS Manufacturing Co., Ltd., of Burleson, TX

D. Schwing Bioset, of Somerset, WI.

E. SPIRAC, of Peachtree City, GA.

F. Or approved equal.

2.3 PERFORMANCE REQUIREMENTS

A. Wet cake hoppers shall be sized and selected to meet the following:

1.	No. of Wet Cake Hopper:	2
2.	Type of Wet Cake:	Dewatered Waste Activated Sludge
3.	Approximate Percent Solids (%):	15 – 18
4.	Approximate Density of Wet Cake (lbs/ft^3):	63
5.	Minimum Volume per hopper (yd^3):	100
6.	Maximum Total Height per hopper (ft):	19
7.	Maximum Width per hopper (ft):	11
8.	Minimum Length (ft):	21
9.	Space between hoppers (ft):	2
10.	No. of Load Cells per hopper:	6
11.	No. of Level Sensors per hopper:	2

B. Live Bottom shall be sized and selected to meet the following:

1.	No. of Shaftless Conveyors, per hopper:	2
2.	Conveyor Length (ft):	
	a. Live Bottom 1:	30
	b. Live Bottom 2:	26
3.	Maximum Live Bottom Width (ft):	4

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

4. Minimum Shaftless Screw Diameter (in): 16
5. Discharge rate into progressive cavity pump (gpm):
   a. Minimum 10
   b. Maximum 40
6. No. of Knife Gates, per live bottom: 2
7. Pump's Hopper Size: 1 meter
8. No. of Drains, per live bottom: 2

2.4 MATERIALS OF CONSTRUCTION

A. Wet cake hopper shall be self-supporting with six structural steel support legs and framing complete with base plates drilled for mounting on concrete base. All necessary cross bracing and reinforcing members shall be fabricated within the support system. Intermediate supports within the hopper will not be acceptable.

B. Unless otherwise specified the materials used in the fabrication of the equipment under this section shall conform to the following:

1.	Hopper:	AISI 304, ASTM A167, 18-8
2.	Inlet/ Outlet Chutes:	AISI 304, ASTM A167, 18-8
3.	Supports:	AISI 304, ASTM A167, 18-8
4.	Discharge Gates:	AISI 304, ASTM A167, 18-8
5.	Twin Screw Shaftless Conveyors:	
	a. Troughs, End Plates, Covers:	AISI 304, ASTM A167, 18-8
	b. Spiral Flights:	Cold formed, High strength Micro Alloy Carbon Steel with minimum hardness of 220 Brinell
	c. Wear Liner:	Two color ultrahigh molecular weight polyethylene sintered with anti-wear filler and synthetic lubricants
6.	Bolts, Nuts and Washers:	AISI 316, ASTM F593 and F594
7.	Platforms:	Galvanized steel supports with aluminum grafting, aluminum toe-plate, and aluminum handrail
8.	Access Ladders:	Aluminum

C. Welds: All welds shall be sealed watertight by continuous welds, unless otherwise specified. Welding to be done by AWS certified welders and constructed and tested in accordance with API-650 including hydrostatic testing of the assembled system. Manufacturer to include any blind or blanking plates to allow the water fill test

D. Edge Grinding: Sharp corners of all cut and sheared edges shall be made smooth by a power grinder.

E. Hopper: Wet cake hopper shall be constructed of welded steel plate of a thickness determined by the manufacturer. It shall be designed to limit maximum deflection of no more than l/240. Minimum plate thickness shall be ¼-inch. Interior surfaces of hopper shall be smooth to allow unobstructed flow. All stiffening of hopper shall be welded to the exterior surface.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

F. Top Cover: Each wet cake hopper shall be supplied with an airtight cover rated for pedestrian traffic (total of 2).

G. Airtight Openings: The wet cake hopper shall be equipped with the following airtight openings:
   1. Three (3) openings in the top cover per wet cake hopper for the three centrifuge discharge conveyors.
   2. Two (2) vents in the top cover per wet cake hopper, one vent to allow air in and the other to be ducted to the odor control located outside of the Biosolids Dryer Building.
   3. Two (2) hinged and bolted 36" x 36" inspection doors per wet cake hopper. One on top and the other on the end above the twin shaftless screws (refer to the Drawings).

H. Access Ladder and Platforms:
   1. Manufacturer shall provide an aluminum access ladder with aluminum safety cage and top grab rails complying with OSHA standards.
   2. Two platforms, in the shape of a "T", are to be designed and provided by the system supplier. First platform is the 2-ft section between wet cake hoppers and the second will be cantilevered along the side of the wet cake hoppers, on the live bottom overhang side.
   3. Any intermediate supports required for platform between wet cake hoppers to be designed and stamped by a Professional Engineer licensed in the State of Kentucky.
   4. Handrails shall be located in all elevated areas around the two wet cake hoppers and shall be aluminum.
   5. During calibration of load cells, platforms and access ladder to be zeroed prior to sludge being discharged into hoppers.

2.5 TWIN SCREW SHAFTLESS CONVEYOR

A. Twin screw shaftless conveyors shall be designed to move the wet cake to the discharge gates situated above the progressive cavity pump hopper. Each screw shall have an independent motor and be the reversing type on VFD. VFDs shall comply with Division 26 Section "Variable Frequency Motor Controllers".

B. One set of double doors and one 10-foot roll-up door will be provided to remove live bottom screws for maintenance activities as seen on the drawings.

C. Screw trough shall be "U" shaped and designed for 1.5 times maximum sludge pressures anticipated from a full hopper. Each trough shall be a maximum of 2-feet in diameter, with 4-feet the maximum total through width.

D. Flights:
   1. Minimum flight thickness shall be 2-inch.
   2. Spiral flighting for the shaftless screw live bottom shall be designed to convey material without a center shaft or hanger bearings, screws using a center shaft of any type for strength will not be accepted.
   3. Spiral flights shall be cold-formed high strength chrome alloy steel with a minimum hardness of 220 Brinnell. The spiral flights shall be designed with adequate stability to prevent distortion and jumping in the trough. A second, inner spiral, concentric with the outside spiral shall also be provided. A third backing section shall be added to the main

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

spiral to increase the strength of the spiral. The torsional rating of the auger flighting shall exceed the torque rating of the drive motor at 125% of its nameplate horsepower. The "spring effect" of the spiral shall not exceed +1.0 mm per 100 mm of length at maximum load conditions. The minimum outer spiral thickness shall be 2.0 mm. Calculations shall be provided in the submittal.

4. The spiral flighting shall be formed in sections from one continuous flat bar and shall be concentric to within ±2mm. Sectional flighting formed from plate shall not be permitted.
5. Spiral flighting shall have full penetration welds at all splice connections. The flights shall be aligned to assure true alignment when assembled in the field and shall be made in accordance with the supplier's requirements. The spiral flights shall be coupled to the end shaft by a flanged, bolted connection.
6. Field welds at the jobsite by the Contractor for installation may be necessary when any overall conveyor length presents shipping or handling constraints.
7. A gland packing ring consisting of two Teflon fiber packing rings shall seal the drive shaft at its penetration through the end plate, along with a greased labyrinth sealing system.
8. The connection of the spiral to the drive system shall be through a flanged connection plate that is welded to the spiral forming a smooth and continuous transformation from the flange plate to the spiral. The drive shaft shall have a mating flange and shall be bolted to the spiral connection plate. Additionally, a grease lubricated labyrinth seal shall be shaft mounted internally in the conveyor between the back plate and spiral coupling connection.

E. Wear liner: The wear liner for each conveyor shall be fabricated of ultra high molecular weight polyethylene with anti-wear filler to reduce wear and synthetic lubricant to reduce friction. The liner shall be provided with a visual (two different color) indicator of excessive wear. The wear liner shall be furnished in maximum four foot sections, 9/16-inch minimum thickness, to provide ease of replacement. The liner shall be held in place with clips; no fasteners will be allowed.

F. Drive Units:
1. Shall comply with Division 26, Section “Variable Frequency Motor Controllers”.
2. Each twin screw conveyor shall be electrically driven by a single electric motor and gear reducer as shown on drawings.
3. Output shall be variable speed capable of discharging at the rates specified herein. Drive shall be capable of reversing direction if any bridging or clogging occurs.
4. Integral gear reducer shall be mounted to an adapter flange mounted to the end plate of the conveyor. The adapter flange shall allow the leakage of any material from the conveyor trough to atmosphere rather than into the gear reducer. Direct coupling of the gear reducer to the end flange of the conveyor will not be acceptable.
5. Drive units shall be rigidly supported so there is no visible “wobble” movement under any operating condition. In the event of a prolonged power failure or emergency system shutdown the drive system shall be designed, at a minimum, to start the conveyor from a dead stop with the trough filled throughout its entire cross sectional area and length with partially dried and hardened dewatered material.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

G. Gear Reducer: All gears shall be AGMA Class II, single or double reduction, helical gear units with high capacity roller bearings. Bearings shall be designed for the thrust loads from the fully loaded startup condition and shall have a AFBMA B10 life of 30,000 hours. The reducer will be the standard air cooled with no auxiliary cooling. The gear reducer shall be sized with a torque service factor if 1.5 times the absorbed power or 1.1 times the motor nameplate, at the driven shaft speed, whichever is greater.

H. Emergency Shutdown: Each twin screw shaftless conveyor shall be furnished with an emergency trip cord and safety switch (total of 4). The cord shall run the full length of each conveyor. The trip switch shall immediately stop both twin screw shaftless conveyors when the switch is actuated.

I. Motion failure alarm unit: An externally mounted motion failure alarm shall be utilized in each live bottom conveyor design to detect spiral drive or shaft failure (total of 4). This function shall be performed by the electronic motor monitor by measuring the "spiral turning, conveyor empty" amp reading a base line and using a lower set point for "no spiral load" for a shaft or spiral failure alarm. The switch shall be Milltronics Motion failure alarm MFA-4p.XPP explosion proof probe with minimum 20-ft cable length, or approved equal.

2.6 DISCHARGE CHUTES

A. Discharge chute shall be isolated from any vibration by flexible connection chute. Pump manufacturer to provide and coordinate transition piece between live bottom and pump inlet hopper with wet cake hopper manufacturer.

B. Single-ply flanged chute shall be EPDM rubber hose, neoprene, Linatrile by Linatex Corporation or approved equal.

2.7 DISCHARGE GATE

A. Each live bottom shall include two discharge knife gates (total of four) that shall be designed to withstand pressures of the wet cake in the hopper. Knife gates to be located on the drive end of each conveyor as seen on drawings.

B. Knife gate to be manually operated with hand wheel. Each knife gate shall close off only one shaftless screw opening. If one screw is down the other can still operate.

C. Discharge gate shall be designed so that in full, open position at least one rotation of the spiral is exposed to the opening in the direction of transport.

D. The knife gate shall be fabricated entirely of AISI 304 stainless steel and suitable non-metallic (UHMW PE) components, all minimum 3/16-inch thickness. The UHMW PE shall have a machined groove to accept the gate blade and give a positive seal. Roller gates are not allowed due to increased and difficult maintenance requirements.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

E. Knife Gate Schedule:

Gate ID	Type	Size (Width x Height)	Head (Seating/Unseating)	Type Operator
BSKV-7226A1	Knife	2'-0" x 2'-0"	Unseating	Manual
BSKV-7225A1	Knife	2'-0" x 2'-0"	Unseating	Manual
BSKV-7126A1	Knife	2'-0" x 2'-0"	Unseating	Manual
BSKF-7125A1	Knife	2'-0" x 2'-0"	Unseating	Manual

2.8 ELECTRICAL / CONTROL SYSTEM

A. Electrical and Control System to comply with Division 26 and Division 40. All electrical equipment shall conform to all applicable standards.

B. A single-point power supply to the equipment will be 480 volts, 60 Hz, 3 phase and operate all system components.

C. System supplier is to furnish one control panel with VFDs, PLC, PanelView, and all necessary controls for a complete and operable system. The Dryer Building has ventilation only, and worse case summer condition is 104 degrees F. If panel cannot handle that temperature, a refrigerant circuit or air conditioner shall be required in panel by system supplier.

D. Both power and control equipment shall be insulated for not less than 600 volts even though operating voltages may be lower.

E. Twin Screw Motors:
1. Motor shall be 480 volts, 60 Hz, 3 phase.
2. Motor shall be high efficiency, 40 degrees C ambient rated, 1.15 service factor and have Class F insulation.
3. Motor shall have a TEFC enclosure with Design B speed/torque characteristics.
4. Motors shall have VFDs that conform to Division 26, Section “Variable-Frequency Motor Controllers”.

F. Control Panel (BSCHCP-7010):
1. Panels shall be NEMA 4X, 316 stainless steel.
2. Control panel shall have an Allen Bradley Control Logix PLC with PanelView as specified in Division 40 Section "Programmable Logic Process Controllers" or approved equal.
3. Equipment control panel shall be factory assembled, wired, and shall contain all necessary control devices for the operation of the live bottoms, discharge gates, load cells, level sensors, and other devices specified herein. Control devices include motor starter, overloads, control power transformer, control switches, pilot lights, relays, interlocks with upstream and downstream process equipment, and other devices as required for a complete and operating system.
4. Control operations shall be as specified in the "Loop Descriptions" at the end of Division 40 Section "Process Control Software". PLC shall communicate via Ethernet to the dry control panel (BSDCP-7030).
5. Entire control panel assembly shall be UL listed and mounted for operator control.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

6. Control panel shall include a main circuit breaker disconnect with externally operable handle lockable in the OFF position.
7. An electric heater with integral thermostat shall be provided in the panel to prevent moisture accumulation.

G. Load Cells:
1. Each support on the wet cake hopper shall have a load cell (minimum of 6 per hopper, total of 12) with controls to be used for continuously monitoring the amount of wet cake within the hopper.
2. Manufacturer to provide a closed loop level control system.
3. Each weighing assembly shall consist of a nickel plated load cell of the shear beam strain gauge type and all appropriate mounting hardware.
4. A flexible cable shall connect each load cell to the indicators for easy remote installation of the readout. Cable lengths shall be a minimum of 50 feet.
5. Weighing assemblies shall be self-checking and have provisions for thermal expansion and contraction. Weighing assembly load plate shall be able to compensate for mounting surfaces up to 4 degrees off-level.
6. Load cells shall have 4-1/2 digit LCD indicator in control panel. LCD Indicator shall be backlit with 0.5" characters for ease of readability in low light conditions.
7. To allow indication of net weight, indicator shall be equipped with a sealed ten turn knob for tare adjustment. Indicator shall output net weight via a 4-20mA signal for remote monitoring. Indicator shall have two adjustable set points for alarms or liquid level control.
8. Approved Manufacturers:
    a. Force Flow of Concord, CA.
    b. Kistler-Morse, of Spartanburg, SC
    c. Sartorius Mechatronics Corp., of Edgewood, NY.
    d. Or approved equal.

H. Level Sensors:
1. Each wet cake hopper shall be furnished with two ultra sonic level senors (total of four). Level sensors are to be located between the three centrifuge conveyors.
2. Level sensors shall be capable of determining if cake unevenly loads the hopper.
3. Level sensor shall be as specified in Division 40 Section "Instrumentation and Control Components" and furnished by system supplier.

2.9 SPARE PARTS

A. Provide the following spare parts:
1. One (1) set of drive shaft and end shaft bearings, seals and dust caps for live bottom discharge screw conveyor.
2. One (1) set of seals for knife gate.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install the wet cake hopper and all appurtenances as shown on the drawings and in accordance with manufacturer’s recommendations.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Any re-design required during installation shall be borne by the awarded manufacturer.

3.2 INSPECTION

A. Inspect the wet cake hopper for shipping damage and to ensure that all accessories arrived undamaged and are in conformance with the specifications.

B. Check all electrical system components for proper connections.

C. Touch up factory coating as required.

3.3 FIELD QUALITY CONTROL

A. Inspection and Check-out
   1. Prior to operating, complete the inspection, testing, and check-out of supporting systems, including but not limited to power, control, and safety systems.
   2. Complete electrical system shall be tested to ensure proper function.

B. Equipment Performance Test
   1. Run system from minimum to maximum specified speed to assure that no damage has occurred during shipment that may affect the performance of the live bottoms.
   2. Calibrate load cells, level sensors, and all instrumentation, prior to start-up.

3.4 MANUFACTURER'S FIELD SERVICES

A. The wet cake hopper supplier shall furnish the services of a factory-trained representative for a period of three days in a minimum of two trips to the jobsite, exclusive of travel time. Service shall be provided as necessary after the Contractor has installed the equipment.

B. These services shall be furnished for the purposes of the equipment manufacturer's inspection of the equipment following installation, and to certify that the equipment has been properly installed and is ready to operate, to train the Owner's personnel in operation, maintenance of the equipment, and to observe and supervise the initial operation of the equipment. Training shall comply with Division 01 Section "Demonstration and Training".

C. The Contractor shall coordinate the Manufacturer's technical services in a timely professional manner. At a minimum, two weeks notice must be given to the Manufacturer for travel planning purposes unless previously agreed by Manufacturer. To avoid project delays, every effort should be made to coordinate inspection, training, and start-up of the equipment.

D. After inspection of the installed equipment the Manufacturer shall furnish a written report certifying that the equipment has been properly installed and lubricated, is in accurate alignment, is free from any undue stress imposed by connecting piping or anchorage, has been operated under full load conditions and that it operates satisfactorily.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Related Sections include the following:
1. Division 01 Section “Quality Requirements”.
2. Division 01 Section "Start-Up Procedures".
3. Division 01 Section “Operation and Maintenance Data”.
4. Division 01 Section "Demonstration and Training".
5. All of Division 40.
6. Division 41 Section "Biosolids Storage System".
7. Division 43 Section "Nitrogen Storage and Distribution System".
8. Division 44 Section “Progressive Cavity Pumps”.

1.2 SUMMARY

A. This Section includes the indirect dryer system that has been pre-purchased by the Owner. Equipment and all appurtenances will be installed as shown on the plans, as recommended by the manufacturer, and in compliance with all OSHA, local, state and federal codes and regulation.

B. Contractor shall be responsible for the installation and coordination of the system.

1.3 SUBMITTALS

A. Submittals for the indirect dryer system will be provided for the Contractor by the Owner.

1.4 QUALITY ASSURANCE

A. The Contractor shall supply all labor, materials, and equipment not pre-purchased by the Owner, including method of installation necessary to complete the work.

1.5 DELIVERY, STORAGE AND HANDLING

A. The indirect dryer system has been pre-purchased by the Owner. Equipment supplier will store equipment until Contractor is ready for installation. Contractor will coordinate transport and installation of equipment with equipment supplier.

1.6 WARRANTIES AND BONDS

A. The complete system shall be covered by a factory warranty, equipment and service, for a minimum of one (1) year from date of acceptance. Warranty includes on-site repair and/or replacement for all failed parts of systems by the supplier.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Manufacturer's Certificate: The indirect dryer manufacturer will submit to the Engineer and Owner, a written report certifying that the equipment has been satisfactorily installed.

PART 2 - PRODUCTS

2.1 GENERAL

A. The BGMU WWTP expansion and renovation includes the addition of Sequencing Batch Reactors (SBRs). Waste-activated sludge (WAS) will be pumped from the SBRs to sludge holding tanks for thickening. The sludge holding tanks are designed to thicken the WAS to 0.8 - 1.5% solids which will then be pumped to the dewatering building. In the dewatering building, the thickened sludge will be dewatered by centrifuges to 15 - 18% solids prior to transport to a wet cake hopper for storage. From the wet cake hopper, biosolids shall be transported by progress cavity pumps to dumpsters for hauling to a landfill or to the dryer system. The dried product shall be stored in silos for truck loading and transport to a beneficial reuse location.

B. One indirect dryer, Model IC10,000, by Therma-Flite, has been pre-purchased by the Owner. Indirect dryer system also includes a thermal fluid heater, scrubber/condenser, and biological odor control system. The thermal fluid heater system includes thermal fluid heater, exothermics tubular heat exchanger, cold seal expansion tank, deaerator tank, buffer tank, thermal fluid recirculation pump, and combustion fan.

C. Items not included as part of the pre-purchased system are the nitrogen storage and distribution system, catchment tank, control valves, and all related appurtenances for complete and operable systems.
   1. For the Nitrogen Storage and Distribution System, reference Division 43 Section "Nitrogen Storage and Distribution System".
   2. Catchment tank shall be located as shown on the Drawings and be a minimum of 200 gallons. Contractor shall coordinate with Therma-Flite on catchment tank material.
   3. All control valves and other related appurtenances required shall be coordinated with Therma-Flite.

2.2 PERFORMANCE REQUIREMENTS

A. Design Criteria:

1.	Method:	Automated, indirect heated, continuous flow dehydration system
2.	Number of Dryers:	1
3.	Minimum Throughput:	24 dtpd
4.	Solids In (%):	15 – 18
5.	Solids Out (%):	≥ 90
6.	Maximum Biosolids Production	
	a. Summer (dtpd):	16
	b. Winter (dtpd):	18
	c. Average (dtpd):	17

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

7. Run Time
   a. Hours /Day: 24
   b. Days /Week: 5
8. Maximum Water Requirements
   a. Potable Water (gpm): 20
   b. Plant Effluent (gpm): 500
9. Product Temperature: < 120 deg. F. exiting product cooler
10. Odor Control
    a. Peak H_2S Loading (ppm): 50
    b. Removal Efficiency (%): 99
11. Final Product Particle Size: 1 - 4 mm $\pm$ 5%

2.3 MATERIALS OF CONSTRUCTION

A. Indirect dryer to utilize 316 stainless steel components to prevent corrosion.

B. Flanges, other than structural connections, shall be ANSI B16, class 150 type, raised face, slip-on weld.

2.4 START-UP AND TRAINING SERVICES

A. Upon completion of the indirect dryer installation and at a time designated by the Owner, the services of one factory service engineer shall be provided for a minimum of ninety (90) man days to assist with installation, start-up equipment, complete performance testing, and train Owner's personnel in the operation and maintenance of the equipment furnished.

B. At least five (5) months after start-up, indirect dryer manufacturer will perform diagnostic review of system to guarantee system is performing as specified. System will be evaluated on overall efficiency. If at this time the system is in non-compliance with manufacturer's standards, system shall be re-worked, at manufacturer's expense, until compliance is achieved.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install the indirect dryer system and all appurtenances as shown on the drawings and in accordance with manufacturer's recommendations.

3.2 INSPECTION

A. Inspect the indirect dryer system for shipping damage and to ensure that all accessories arrived undamaged and are in conformance with the specifications.

B. Check all electrical system components for proper connections.

C. Touch up factory coating as required.

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3.3 FIELD QUALITY CONTROL

A. Inspection and Check-out
   1. Prior to operating, complete the inspection, testing, and check-out of supporting systems, including but not limited to power systems, control systems and safety systems.
   2. Complete electrical system shall be tested to ensure proper function.

END OF SECTION

© 2010 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.



BOWLING GREEN MUNICIPAL UTILITIES
BOWLING GREEN, KENTUCKY
Wastewater Treatment Plant Expansion and Renovation

Therma-Flite Biosolids Dryer System
IC-10000 BIO-SCRU

PURCHASE ORDER AGREEMENT

TERMS AND CONDITIONS

BGMU Project No. S07-653
GS&P Project No. 26064.00

MARCH 14, 2010

PURCHASE ORDER AGREEMENT

TERMS AND CONDITIONS

BIOSOLIDS DRYER SYSTEM

---

1 OVERVIEW

1.1 Product Description

Therma-Flite, IC 10000 is an automated, indirectly heated, continuous flow biosolids dryer system with an ASME code-stamped thermal fluid heating module and dryer module. The dryer shall be a complete turnkey biosolids dryer system, modularly designed for ease of installation. Programmable logic controller (PLC) automation and control of the IC series system insures meeting Class A biosolids requirements as defined by Title 40 CFR (Code of Federal Regulations), Part 503 – Standards for the Use and Disposal of Sewage Sludge, while processing on a continuous basis with minimal operator attention.

1.2 Scope

The scope of this Purchase Order Agreement includes the design, and furnishing of a complete IC-10000 Bio-Scru Dryer System from Therma-Flite, hereafter referred to as the **Supplier**, by Bowling Green Municipal Utilities (BGMU), hereafter referred to as the **Owner**. The biosolids dryer system shall be factory assembled and disassembled as required for transport to the project site located in Bowling Green, Kentucky. The biosolids dryer system shall consist of (1) one unit, consisting of the following components and all accessories agreed to for a complete and operational system:

1.2.1 HOLO-SCRU® Dryer with integrated BIO-SCRU® rotors
1.2.2 Thermal fluid heater, expansion tank, de-aerator tank, and thermal buffer tank
1.2.3 Cooling screw
1.2.4 Condenser / Odor Scrubber

1.2.5 Odor Control System
1.2.6 Control panel

1.3 How the IC-10000 BIO-SCRU, Biosolids Dryer System Works

The HOLO-SCRU's® drying chamber is a sealed, sub-ambient pressure, anaerobic atmosphere. The drying chamber is kept constantly full to minimize head space in the chamber and to maximize the thermal operating efficiency. The HOLO-SCRU's® heat energy is provided by the thermal fluid circulating through the hollow rotor flighting, rotor shaft and dryer chamber housing. This method of heating is indirect, meaning the heating medium is not in contact with the product being heated. The HOLO-SCRU's® dual-rotor design includes proprietary features which make the rotors self-clearing. This feature breaks up any sludge that may bake onto the rotors and form clumps. The HOLO-SCRU® design can also incorporate mixing blades, which break up any large clumps and homogenize the particle size to insure the sludge is uniformly heated throughout the unit. The HOLO-SCRU® utilizes a multi-sensing-point method for failsafe operation. The PLC-controlled scrubber/condenser insures that small particulate blow-off is captured within the condensate stream to minimize odors.

2 PERFORMANCE AND CAPACITY

2.1 IC 10000 Operation Parameters

2.1.1 Method: Automated, indirectly heated, continuous flow dehydration system.
2.1.2 Capacity: 10,000 pounds of water removed per hour.
2.1.3 24 dry tons per operational day.

IC 10,000					
Water Removal Capacity	10,000 Lbs/Hr				
Hourly feed rate drying to 90% solids (lbs/hr)	11,538	12,000	12,500	13,043	13,846
% Solids in feed (minimum 14%)	12	15	18	21	25

2.1.4 Process feeds can include digested, undigested, waste-activated sludge (WAS), or a mixture of multiple types of sludge as is common in regional facilities.

2.1.5 Designed for variable processing rates up to continuous 24/7 operation.

2.2 Energy Utilization

2.2.1 Dryer chamber efficiency: 96%. Heat load: 1,135 MMBtu/pound water removed.

2.2.2 Thermal fluid heater with pre-heater economizer, efficiency: 93% (LHV) natural gas burner.

2.2.3 Thermal fluid heater heat output: 12 MMBtu

2.2.4 Natural gas fuel consumption:

Dryer Heat Load:

- 1,135 MMBtu /pound water removed
- 10,000 lb/hr water removed
- 11,350,000 Btu/hr @ 100% Eff.
- 11,822,917 Btu/hr @ 96% Eff.

Thermal Fluid Heater Requirements:

- 11,822,917 Btu/hr Total Energy Required
- 93% Boiler Efficiency LHV
- 12,712,813 Btu/hr Boiler Energy Requirements
- 970 Btu/ft^3 Natural Gas LHV
- 1,271 MMBtu's per Lb H_2O Evaporated.

2.3 Electrical Motors

2.3.1	Dryer screws drive	15 hp
2.3.2	Combustion fan	20 hp
2.3.3	Thermal fluid pump	60 hp
2.3.4	Condenser fan motor	1 hp
2.3.5	Cooling screw conveyor	3 hp
		99 total hp

Note: Horsepower ratings are for the BIO-SCRU® System. Final layout and

auxiliary equipment may change the total connected horsepower. Therma-Flite shall provide all horsepower loading as part of the shop drawings for the system.

2.4 Utilities

2.4.1 Natural gas pressure required: 120" wc

2.4.2 Fuel input: natural gas (@1,000BATU/CU.FT.) 14,998 ft^3/hr

2.4.3 Condenser water required: Cooling Water @ 78°F - 10,650,000 Btu/hr. GPM required 420 gpm (worst case) at 45 psi, not to exceed 60 psi of water flow. If process water is used, it must be filtered through a 300 micron filter before delivery to the condenser/scrubber. Filtration and shut off valve supplied by Owner. Return temperature of the water is 130°F.

2.4.4 Cooling Screw water required: Cooling Water @ 78°F. GPM required 30 gpm (worst case) at 45 psi, not to exceed 60 psi of water flow. Return temperature of the water is 88°F.

2.4.5 Main electrical disconnect: 200 amp Dryer System

2.5 Liquidated Damages – Delivery

2.5.1 If completion of the project is delayed due to failure to meet the delivery date as provided by the contractor at the start of the Owner's wastewater treatment plant project, liquidated damages will be assessed in the amount of $500.00 per calendar day.

2.6 Liquidated Damages – Performance Guarantee

2.6.1 Unit is sized to evaporate 10,000 lbs of water per hour. Increased throughput beyond 10,000 lbs per hour water removal rates are achieved at a decreased efficiency rate. Performance guarantee on the maximum BTU's per lb of water evaporated is 1,465 MMBTU's. Guarantee based on testing as stated in Specification Section 44 4618 2.4.B of the Request For Proposals (Appendix A). Calibrated gas meter and pressure regulator with no other usage

points between it and the thermal fluid heater will be required (to be supplied by Owner).

2.6.2 If natural gas usage exceeds 1,400 MMBTU/lb of water removed, liquidated damages in the amount of up to **$500.00 per calendar day** will be assessed starting four days after written notification that the maximum utility usages are being exceeded.

2.6.3 If natural gas usage exceeds 1,465 MMBTU/lb of water removed or if material fails to meet Class A as defined by Title 40 CFR Part 503 Regulations, liquidated damages in the amount of **$1,500 per calendar day** will be assessed.

2.7 Miscellaneous

2.7.1 The flue gasses are to be exhausted in a minimum 28" diameter duct provided by Owner.

3 COMPLIANCE WITH TITLE 40 CFR, PART 503 RULES TO PRODUCE CLASS A BIOSOLIDS

3.1 The Therma-Flite Sludge Dryer shall produce Class A biosolids reliably while complying with the Title 40 CFR, Part 503 regulations. Compliance with both the pathogen reduction and vector attraction reduction requirements for Class A biosolids is met with different operating regimen and compliance logging options.

3.2 By residence time and temperature, the pathogen reduction requirement Title 40 CFR Part 503.32(a)(2) is met using time and temperature regimen A Alternative 1 for "every particle" in the sludge mass. This requirement is for the temperature to equal or exceed 167°F for 20 minutes for every particle. The residence time at greater than 167 °F is determined by the transport rate of the screw. The MINIMUM residence time is measured between the point where the temperature of the material is measured to be greater than 167 °F and the first edge of the discharge port. Test ports are provided for manual verification of the temperature at the initiation of the residence time. Temperature and the machine speed/residence time are recorded automatically with a time stamp; it is a compliance record.

3.3 The vector attraction reduction requirement is met by Option 8 of Title 40 CFR, Part 503.33(b)(8) for any sludge by drying to greater than 90% solids.

3.4 The Therma-Flite Sludge Dryer shall qualify as a PFRP (Processes to Further Reduce Pathogens) as defined by Title 40 CFR, Part 503.32(a)(7)(ii), Appendix B-(B)(2), Heat Drying. Using this alternative, the sludge is dried to less than 10% moisture and the temperature of the exiting material is greater than 176 °F. The compliance logging for this alternative records the temperature of the exiting material with a date stamp. This complies with both the pathogen reduction and the vector attraction reduction requirements for Class A biosolids as defined by Title 40 CFR, Part 503.

4 MAJOR COMPONENTS

4.1 System

4.1.1 Method: Automated continuous process.

4.2 Dehydration Chamber

4.2.1 Material of construction, surfaces in contact with wet biosolids shall be manufactured from 316L Stainless Steel. All non wetted surfaces shall be manufactured from 316L Stainless Steel or Carbon Steel.

4.2.2 Each Therma-Flite IC dehydrator section shall be in accordance with ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, latest edition and was fabricated by certified welders.

4.2.3 ASME code stamped housing.

4.2.4 ASME code stamped HOLO-SCRU® auger/blender.

4.2.5 W trough type dehydration chamber shall be insulated with high density fiberglass insulation as required to maintain a surface temperature of below 140 °F.

4.2.6 W trough includes sample ports located near the product thermal couples, for calibrating the thermal couples and taking grab samples.

4.2.7 The dehydrator top shall be furnished with an inspection cover.

4.2.8 One (1) steel dehydration chamber with a smooth inner surface and a thermal fluid external jacket integrally welded to the dehydration chamber for heat transfer to the dehydration chamber wall.

4.2.9 Two (2) thermal fluid heated HOLO-SCRU® auger/blenders fabricated from 1/4" and 5/16" steel, complete with lifters to enhance particle redistribution and heat transfer.

4.2.10 Two (2) dual pass rotary unions provide the thermal fluid inlet and outlet to the rotating auger/blenders.

4.2.11 One (1) dehydrator drive package complete with reversible motor, gearbox, drive train and bearings.

4.2.12 Multiple thermocouple probes located along the length of the dryer for temperature readings and control, including thermal fluid, dehydration vapor, thermal fluid expansion tank, and thermal fluid return from the shell and HOLO-SCRU® rotors.

4.2.13 Thermal fluid inlet and outlet shall both be a single connection points on the dryer. All thermal piping on dryer from the connection point to the delivery points and collection points shall be furnished and installed as part of the dryer.

4.3 Frames & Support Structure

4.3.1 One (1) structural steel frame designed and fabricated to support the dehydration chamber and motor drive package.

4.3.2 One (1) heavy duty, structural steel support base to support the dehydrator drive package.

4.3.3 The frame and support structure shall be designed and manufactured to allow expansion and contraction of the dryer when heated and cooled.

4.3.4 The paint system for the non-stainless steel portions of the dryer shall be specified by the Owner or Owner's representative.

4.4 Discharge Cooling Screw

4.4.1 One (1) dried sludge discharge system consisting of an enclosed auger, with cooling jacket, to convey the dried sludge to a discharge point on one side of the dehydration chamber.

4.5 Thermal Fluid Heater

4.5.1 One (1) ASME code stamped high efficiency thermal fluid heater with air pre-heater.

4.5.2 All necessary thermocouples and instrumentation for the heater shall be included for a complete and operational system.

4.5.3 Actual natural gas usage will vary depending on the amount of water being evaporated.

4.5.4 Fuel burners gas train: Arranged and piped to ASME CSD 1.

4.5.5 Heating oil burners: Arranged and piped to factory mutual standards.

4.5.6 Hot air/thermal fluid, ASME Section 1 code stamped heat exchanger.

4.5.7 Internals of the thermal fluid heat exchanger are steel and designed for industrial use. The outer shell of the thermal fluid heater is painted with high temperature paint.

4.5.8 An industrial burner system will be supplied with fuel burning units consisting of burners appropriate to customer's selected fuel source, control valves, temperature controls and piping.

4.5.9 A special thermal fluid pump, filter, and valves will be furnished to circulate the thermal fluid through the dehydrator system.

4.5.10 A thermal fluid expansion tank, complete with a relief port, is mounted in an elevated position with the de-aerator tank and thermal fluid buffer tank.

4.5.11 Nitrogen padding system shall be provided with controls. Nitrogen storage system shall be provided by Owner.

4.5.12 The entire unit will be fabricated, assembled and tested before shipment.

4.5.13 Thermal fluid: Therminol® 55 or better.

4.6 Burner System

4.6.1 One (1) industrial burner system consisting of one (1) natural gas burner with modulating controls configured to meet ASME CSD 1.

4.6.2 The system is pre-piped and pre-mounted.

4.6.3 The included programmable controller will run various time/temperature regimes for total control of the dehydration process.

4.6.4 Times and temperature regimes will be established during machine startup and entered into the programmable controller.

4.6.5 All necessary thermocouples and instrumentation are furnished in this proposal.

4.6.6 Actual natural gas usage will vary depending on the amount of actual water being evaporated.

4.6.7 System shall be a High Efficiency thermal fluid heater.

4.7 Electrical

4.7.1 **General Information:** Therma-Flite will, at no additional cost, modify any of the below listed electrical specifications to match the Owner's requirements as per the bid specifications.

4.7.2 Control Panel

4.7.2.1 Control enclosure: Stainless steel, NEMA 250, UL labeled for industrial enclosures. UL stamped Industrial control enclosure.

4.7.2.1.1 Allen Bradley Control Logix programmable controller with touch panel HMI display is provided complete with internal timers to control the time/temperature regimes and machine functions.

4.7.2.2 The PLC supplied by Therma-Flite shall be interfaced compatible with the SCADA system selected and used for process and monitoring control of the wastewater treatment plant (WWTP).

4.7.2.3 Square D, thermal magnetic contactors.

4.7.2.4 One (1) main disconnect is provided in the enclosed cabinet.

4.7.2.5 One (1) additional main disconnect will be provided at the device.

4.7.2.6 I/O devices are included in the PLC panel to provide output to a historian system or paper charter, for continuous monitoring to certify that the dried sludge meets the requirements for Class A sludge.

4.7.2.7 I/O shall have Ethernet communication link to WWTP SCADA system.

4.7.2.8 Outputs for additional recorders, for record keeping, or SCADA systems, can be furnished at an additional cost.

4.7.3 Wiring

4.7.3.1 Machine wiring: Wired to national electrical codes.

4.7.3.2 Conduit: All conduits will be rigid except where liquid tight is required and approved.

4.7.4 Supplied Manuals and Diagrams

4.7.4.1 Therma-Flite will supply ladder logic diagrams and initial cycle programming for one (1) time temperature dehydration cycle.

4.7.4.2 All hard wiring schematics are furnished.

4.8 Condenser/Scrubber

4.8.1 Brass valves.

4.8.2 304 SS nozzles.

4.8.3 Water shut-off valves, pressure-reducing valves or flow meters supplied by Owner.

4.8.4 A high efficiency enclosed wet Venturi type scrubber is provided to remove airborne particulate.

4.8.5 Condenser water will be piped back to the waste treatment system by the Owner.

4.8.6 Condenser/Scrubber shall be a complete and operational system.

5 ODOR CONTROL

5.1 Odor Control

5.1.1 Airflow Rate : up to 500 cubic feet per minute (cfm) if open to vent. Typical is between 5-20 cfm.

5.1.2 Average/ peak H2S Loading : 20 ppm/50 ppm (actual values not known at this time)

5.1.3 The odor control equipment recommended by Therma-Flite shall be approved by the Owner prior to purchase.

5.1.4 The odor control equipment shall, at a minimum, meet the performance criteria of 99% H_2S removal efficiency as defined in Section 2.4 A(10)(b) of the RFP specifications.

5.1.5 The control panel includes a PLC to provide all the necessary controls required to control the odor control system including irrigation system, nutrient injection system and fan blower. The combination control panel is pre-wired and supplied loose to be mounted by others next to, but at least 3 feet from reactor, and requires utility connections and electrical connections be provided by others.

5.1.6 One (1) FRP Blower Fan: The blower is used to supply the foul air to the Bio-filter for treatment. The blower will be FRP construction, belt driven, centrifugal type, and manufactured by New York Blower (or equal). Blower sizing is based upon the pressure drop through the discharge side or tower. The equipment supplier/vendor is responsible for checking the size of the blower to ensure the design meets the suction side pressure drop requirements. The engineer will review design calculations and shop drawings for the FRP blower. Pressure loss in reactor is approx. 1"wc.

6 OPERATIONAL SAFETY

6.1 Dryer Chamber

6.1.1 The drying chamber includes purge gas connections to supply inert (nitrogen) gas padding to the system during startup and shutdown or while steam production is below what is required for normal operation. Gas feed is controlled automatically via a solenoid valve.

6.1.2 Drying chamber will include water nozzles along the length of the dryer. In the event of an over-temperature, a solenoid valve will actuate, initiating a saturation of the bio-solids in the drying chamber. After completion of the saturation cycle, the dryer will initiate a slow heat up and bake out to insure the product in the chamber is thoroughly dried before discharge. An override control button can be added the control panel if desired by the Owner.

6.1.3 Dryer chamber covers and access ports include breach sensors which will initiate an audible alarm sequence if someone attempts to open the drying chamber while at temperature.

7 MANPOWER & MAINTENANCE

7.1 Dryer System Operation

7.1.1 The system is PLC controlled and automated and does not require a dedicated full time employee. Normal operation requires minimal operator attention.

7.2 Maintenance

7.2.1 Assuming an operations schedule of 24 hours - 7 days per week (24/7), maintenance would be around 200 to 250 hours annually.

7.2.2 Annual replacement parts would average approximately $3,000 to $4,000 per year.

8 QUALITY ASSURANCE

8.1 Single Source

8.1.1 The Therma-Flite IC Series equipment specified in the proposal will be an integrated system. Supplier provides a single source responsibility for all components in the IC Series equipment and ancillary equipment provided by Supplier to complete the package as described in this agreement.

8.1.2 Quality: All components of the Therma-Flite IC dehydration system shall be engineered for long continuous and uninterrupted service. Provisions shall be made for easy lubrication, adjustment or replacement of all parts. These provisions include easily accessible points for lubrication, adjustment of bolts, replacement of seal packing, and other general/routine maintenance requirements.

8.2 Standards

8.2.1 Thermal fluid heating equipment, drying chamber and HOLO-SCRU® heat exchanger rotors are ASME code stamped pressure vessels, insuring optimum safety and longevity of operation.

8.3 Qualification for Welding Work

8.3.1 Welding Procedures Specifications (WPS) and Procedure Qualification Records (PQR) shall be in accordance with AWS D1.1 and ASME Sec. IX as applicable.

8.3.2 Certifications for welder qualification shall include the type of welding and positions each operator is qualified for, the code and procedure qualified under, date qualified, and the certifying activity.

8.4 Welding Documentation

8.4.1 Therma-Flite shall qualify the welding procedures and welders by tests prescribed in the applicable Code of Construction.

8.5 Heat Input Requirements

8.5.1 Welding shall not be done at ambient temperature below 32 °F, or when the surfaces are wet or exposed to rain or high wind. Temperature of the metals in the area where the welding is to be done shall not be less than 50 degrees. F. When the ambient conditions are such that the normal temperature of the base metal is below 50 °F, the area surrounding the joint shall be preheated to provide a base metal temperature of 100 °F for a distance of at least 3 inches in all directions from the joint to be welded. For ambient temperatures above 50 degrees, the requirements of the applicable WPS shall apply.

8.6 Interpass

8.6.1 In a multi-pass weld, the interpass temperature is the temperature of the weld melt before the next pass is started. Proper interpass temperatures are specified on the applicable WPS.

8.7 Post-weld Heat Treatment

8.7.1 Weldments shall be given a post-weld heat treatment when noted in the applicable WPS and supporting PQR.

8.8 Inspection/Non Destructive Examination (NDE)

8.8.1 Therma-Flite shall perform fabrication/assembly inspections as necessary prior to assembly, during assembly, during welding, and after welding to ensure that materials and workmanship meet the requirements of the Code of Construction.

8.8.2 Unacceptable welds shall be immediately repaired and made ready for re-inspection at no additional cost to the customer.

8.9 Methods of NDE

8.9.1 Visual inspection (VT) for cracks and other discontinuities of structural steel weldments shall be performed in accordance with the applicable Code of Construction.

8.9.2

8.9.3 Level of examination shall be 100%.

8.9.4 Supplier shall record all inspections on the shop fabrication traveler.

8.10 Quality Control

8.10.1 Each module of the Therma-Flite IC system will be totally piped, wired, inspected and tested prior to shipment.

8.10.2 Suppliers Quality Control will test and document all phases of manufacturing and testing.

9 COMPONENT SPECIFICATIONS

9.1 Equipment

9.1.1 Equipment Classification will be NFPA 654 & 820 unless noted as otherwise.

9.2 Code of Construction

9.2.1 Structural welding shall be in accordance with AWS D1.1-2002 using the shielded metal-arc method or gas-shielded arc method described in the American Welding Society's "Welding Handbook" as supplemented by other AWS standards. Qualification of welders shall comply with AWS Standard AWS B2.1-98.

9.2.2 All pressure vessel construction shall be in accordance with ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, 2007 edition and shall be fabricated by certified welders.

9.3 Coatings

9.3.1 Steel fabrications will be sand blasted and coated with one (1) coat of zinc rich primer and a minimum of 3 millimeter thickness of corrosion resistant coating.

9.3.2 Any defects or damage caused in manufacturing will be thoroughly cleaned, wire brushed, wiped clean with a suitable solvent and dried. The prepared area will be coated with a zinc rich compound specifically formulated for wet environments. The zinc rich coating will be a minimum of 3 millimeters thick and will be in accordance with SSPC standards.

9.4 Seals

9.4.1 The thermal fluid pump is manufactured by Dean Pump or equal.

9.4.2 Seal specifications are:

- 9.4.2.1 Max. pressure- 350 PSIG
- 9.4.2.2 Max. temperature- 650 °F
- 9.4.2.3 Air cooled seals
- 9.4.2.4 Stationary seal- silicon carbide, and Viton®

9.4.3 Rotary seal- stainless steel, carbon and Viton®

9.4.4 Thermal fluid rotary joint seals. Rotary joints are Johnson Products, or equivalent.

- 9.4.4.1 Convex, self-aligning carbon seal ring, for extended life.
- 9.4.4.2 Internal SS spring
- 9.4.4.3 Two (2) Internal, extended, carbon guides

9.5 Bearings

9.5.1 Bearings will be oil or grease lubricated, with lubrication points piped to a central lubrication block for ease of lubrication.

9.5.2 Bearings shall be a minimum of L-10 rated life of 50,000 hours.

9.6 Balance

9.6.1 Drive motors are manufactured by Sumitomo or equal.

9.6.1.1 Balancing specifications are:

9.6.1.1.1 To ISO 1940/73

9.6.1.1.2 ISO procedure states the following equation: U=(e X m) /R

9.6.1.1.3 Where e= maximum residual unbalance in function of speed, mass and balance.

9.6.1.1.4 Grade (G) (mm X g/kg)

9.6.1.1.5 m = mass of rigid rotating body (kg)

9.6.1.1.6 R = balancing radius (distance from the center of the shaft to the compensating position (mm)

9.6.2 The condenser blower is manufactured by New York Blower or equal.

9.6.2.1 Balancing specifications are:

9.6.2.1.1 To AMA 204, section 6, quality grade G2.5 standards.

9.6.2.1.2 The thermal fluid heater burner is supplied by Fulton Thermal Corp or equal. Blower balancing specifications are:

9.6.2.1.3 To ISO 1940-73, as stated at 1.05, 8, b & c.

9.7 Equipment Guards

9.7.1 Equipment guards are designed for OSHA regulations and are 18 gauge steel. Guards are designed for easy inspection and removal.

9.7.2 Guards shall be sand blasted to near white and painted with safety yellow

9.7.3 Chemical and fade resistant decals shall be affixed to the equipment. Decals will be displayed in areas that are visually obvious to warn of safety hazards.

9.8 Hardware

9.8.1 Bolts shall be ASTM Class 449, Type 5 or greater.

9.8.2 Flanges, other than structural connections, shall be ANSI B16, class 150 type, raised face, slip-on weld.

9.8.3 Pipe threads shall be ANSI 11.5 V or 8V, depending on size.

9.9 Electrical

9.9.1 Contactors shall be thermal magnetic, rated for 30 million operations.
9.9.2 Contactors: UL, ASE, and CSA approved.
9.9.3 Switches: 22 mm Square D
9.9.4 Temperature controller: Fuji model PYX ¼ Din.

10 GENERAL OPERATION: PLC CONTROLLED AUTOMATIC PROCESS

10.1 The Therma-Flite IC

10.1.1 Under PLC control, started in preheat mode to heat the thermal fluid to a system operating temperature.

10.2 The PLC Automation Control

10.2.1 Dryer section is preheated to operating temperature.
10.2.2 PLC activates the sludge in-feed.
10.2.3 The progressive cavity pump feeds biosolids to the dryer chamber
10.2.4 The internal, thermal fluid heated, dual rotor system moves and breaks up the biosolids to create maximum exposure to the heated surface of the rotors and the thermal fluid heated dryer chamber. The intermeshed dual rotor system eliminates clogging during the plastic phase of the drying sludge, and creates maximum particle relocation for release of trapped moisture.
10.2.5 The PLC senses the satisfaction of the time/temperature requirement of the continuous dehydration process.
10.2.6 Material that has met the time and temperature requirement is discharged continuously from the dryer section.
10.2.7 This automatic continuous process continues until the operator stops the sequence and places the system into cool down mode or the system runs out of in-feed material.
10.2.8 As an inherent function of the indirectly heated, continuous flow drying process the drying chamber is oxygen deprived and

continually steam purged as the water is evaporated from the sludge, creating a safe drying environment.

11 MODULARIZATION

11.1 Main Module Dehydration Section, including:

11.1.1 HOLO-SCRU® blender heat exchanger.
11.1.2 Jacketed and insulated heat exchanger chamber.
11.1.3 Rotary unions.
11.1.4 Electric motor and gearbox drive system.
11.1.5 Packing gland style seals.
11.1.6 Air scrubber, steam condenser system, including:
- 11.1.6.1 Venturi scrubber chamber.
- 11.1.6.2 Impingement/cooler condenser system.
- 11.1.6.3 Exhaust blower.
- 11.1.6.4 Integral ducting system.

11.2 Dried Solids Discharge Conveyor, including:

11.2.1 Electric motor and gearbox drive system.
11.2.2 Enclosed auger conveyor

11.3 Electrical Enclosures, including:

11.3.1 Main control enclosure
11.3.2 Main wiring conduits and junction boxes.

11.4 Heavy Duty Equipment Skids, Designed For Easy System Erection

11.5 Thermal Fluid Heater Section, including:

11.5.1 Thermal fluid heater.
11.5.2 Industrial gas or oil burner.
11.5.3 Pre-piped gas control system. ASME CSD 1.
11.5.4 Thermal fluid expansion tank.
11.5.5 Thermal fluid de-aerator tank.
11.5.6 Thermal fluid buffer tank.
11.5.7 Heat Exchanger to pre-heat the air.
11.5.8 Blower for combustion air.
11.5.9 Integral piping and valves.
11.5.10 Thermal fluid pump.
11.5.11 Heavy duty equipment skid, designed for easy system erection.

12 MANUALS, DRAWINGS AND SUBMITTAL PACKAGES

12.1 Manuals

12.1.1 Three (3) Owner's manuals will be provided, complete with as-built drawings.(Additional manuals and drawings will be provided on CD.)

12.2 Submittals

12.2.1 Eight (8) submittal packages will be provided, complete with submittal drawings.

13 PERFORMANCE AND ACCEPTANCE

13.1 Performance Test

13.1.1 The performance test shall consist of a minimum of three (3) independent tests. Each test shall be performed over a minimum of 24 hours unless authorized and agreed upon by Owner. Each

test will include an evaluation of normal start-up and shut-down procedures as well as operational performance.

13.1.2 The performance tests will be conducted in a manner that allows thorough evaluation of the entire dryer operation to produce a dried Class A biosolids in accordance with the requirements of Title 40 CFR, Part 503.

13.1.3 The Owner will give acceptance after three (3) consecutive 24 hour tests meet the performance guarantees defined in Section 2.6 above as well as conformance with Title 40 CFR, Part 503 regulations for a Class A heat dried biosolids.

13.1.4 The Owner will have a test laboratory available to collect samples to be analyzed. Sampling and analyses shall conform with approved EPA methods.

13.1.5 Sampling and testing costs shall be the responsibility of the Owner.

13.1.6 The Owner does have the option of accepting the system per the time/temperature regime and the percent solids.

14 START-UP ASSISTANCE / INSTALLATION SUPPORT

14.1 Startup Support and Installation Support

14.1.1 Therma-Flite will provide a trained technician for up to fifteen (15) days to startup and program the system and train the operators. If additional days beyond this are required due to operational or start-up issues, Therma-Flite will extend start-up support up to ninety (90) days at no additional cost to the Owner.

14.1.2 Therma-Flite will provide a trained technician for up to three (3) days to review and/or supervise the installation of utility connections.

14.1.3 Extra days (beyond 3 days for installation, and 90 days for startup) are available at actual cost for labor (when included in the same trip) per man-day, plus expenses based on BGMU's travel policy:

14.1.3.1 **Lodging** – $70.00 per day

14.1.3.2 **Meals** – $46.00 per day

14.1.3.3 **Rental Car** – Daily rate for mid-size vehicle

Note: A minimum of 15 business days' notice will be provided to make arrangements for a Therma-Flite technician to startup the drying system.

15 INSTALLATION (OPTIONAL)

15.1 Scope of Installation Support Provided

15.1.1 As required to bolt the IC Modules to the concrete.

15.1.2 As required to bolt the IC modules together and make the required interconnections for piping, conduit and electrical between the skids.

15.2 Installation Provide by Others

15.2.1 Placement of the IC Modules in the building near the final installation location. Therma-Flite will utilize equipment dollies to make the adjustments in the equipment placement to finalize the install location.

15.2.2 Utility connections to the skids for process water, power, natural gas, etc.

16 LIMITED WARRANTY

16.1 Limited Warranty

16.1.1 The Therma-Flite IC Sludge Dehydrator, manufactured by Therma-Flite, is guaranteed to be free from defects in materials and workmanship for a period of one (1) year from date of start-up or twenty-four (24) months from delivery, whichever ends first. Therma-Flite's obligation under this warranty shall provide all parts and labor for the repair or replacement of any part deemed defective under this warranty.

16.2 Conditions of Warranty

16.2.1 The equipment shall be used only by persons who are considered knowledgeable and properly trained by Therma-Flite, Inc. and holding a "Certificate of Competency" for operation of a IC 10,000 Series Dryer as provided by Therma-Flite.

16.2.2 No highly corrosive compounds, abnormal to typical municipal wastewater, shall be introduced into the dehydrator.

16.2.3 The equipment shall be used in accordance with local, state and federal rules, regulations, laws, ordinances and guidelines.

16.2.4 All repairs and replacement parts furnished under this warranty shall be FOB project site in Bowling Green, Kentucky. This warranty does not cover damages resulting from accident, misuse, abuse, neglect or alteration.

17 MAINTENANCE AGREEMENT: (PROVIDED AT NO ADDITIONAL COST)

17.1 Parties involved

17.1.1 This contract is between the Owner and Therma-Flite, Inc., the equipment manufacturer, for the purpose of providing maintenance and repair on the following system. This contract will be performed in conjunction with the normal limited warranty program during the warranty period, and as a separate agreement post warranty.

17.2 Duration of Contract

17.2.1 Twelve (12) months from the date of start up of the system.

17.3 Annual Preventative Maintenance

17.3.1 At start-up of the system the BIO-SCRU® system will be tested, lubricated, and balanced for heat load efficiency by a Therma-Flite technician.

17.3.2 At five (5) months from start-up, a Therma-Flite technician will:

17.3.2.1 Perform the same diagnostics as at start-up.

17.3.2.2 Perform manufacturer's recommended PM check-up on bearings, seals and gearboxes.

17.3.2.3 Evaluate the system for overall efficiency, operation procedures and preventative maintenance programs.

17.3.2.4 At eleven (11) Months from start-up, a Therma-Flite technician will:

17.3.2.4.1 Perform the same diagnostics as at start-up.

17.3.2.4.2 Perform manufacturer's recommended PM check-up on bearings, seals and gearboxes.

17.3.2.4.3 Evaluate the system for overall efficiency, operation procedures and preventative maintenance programs.

17.4 Equipment Repair Support

17.4.1 Minor components

17.4.1.1 Minor component adjustment or failure will be diagnosed with the assistance of a Therma-Flite technician by telephone communication with a qualified agent, mutually approved by the Owner and Therma-Flite, performing the repair.

17.4.1.2 Minor components are generally defined as electrical components, motors, gearboxes bearings and similar components that typically require skilled maintenance personnel.

17.5 Major Components

17.5.1 Major component repair or replacement will be performed with the assistance of qualified Therma-Flite technicians.

17.5.2 Major component adjustment or failure shall be defined as repair or replacement of parts or components that are part of the ASME pressure vessel portion of the system.

17.5.3 Repairs that will require substantial draining of thermal fluid to perform the repair.

17.5.4 Repairs to the ASME CSD 1 components of the burner system that may affect the burner efficiency.

17.6 Expenses

17.6.1 Air travel and food expenses shall be at the expense of Therma-Flite.

17.6.2 Special test equipment or tools not typical to a normal maintenance department shall be at the expense of Therma-Flite.

17.6.3 Hotel shall be at the Owner's expense at a cost not to exceed the daily rate as defined by the Owner's travel policy (refer to Section 14.1.3) for hotel accommodations. Any cost over this amount will be borne by Therma-Flite.

17.6.4 Lifting or moving equipment for heavy components and basic maintenance tools shall be the Owner's obligation.

17.6.5 Any expenses incurred because of a delay in the Therma-Flite technician being allowed to perform repairs per a predetermined schedule, if the delay is at the request of the Owner, will be billed to the Owner. These expenses shall not exceed the daily rates defined by the Owner's travel policy (Section 14.1.3).

PRICING AND TERMS OF SALE

This proposal covers the requirements to design and furnish a complete IC 10000 sludge dryer. The Sludge dryer system consists of One (1) automated dryer system. The system shall be a prefabricated unit consisting of an ASME code stamped sludge dehydration chamber, ASME code stamped thermal fluid heat exchanger, control panel, scrubber/condenser and required integral conveying devices.

Item	Conditions	Budget Unit Price
IC-10000 Bio-Scru Dryer	• 316L Stainless Steel Wetted Parts • Shipping Included	**$2,971,780.00**

TERMS

Terms of payment are:

30% Upon Approval of Shop Drawings
30% Upon receipt/invoice of major materials
30% Upon Delivery of the Drying System
5% At Startup
5% At Completion of Punch List

DELIVERY

Delivery of the "HOLO-SCRU" Dryer can be accomplished in **36-40 weeks** from our receipt of the approved general arrangement drawing on a standard schedule. The schedule and time of delivery is somewhat flexible and can be discussed based upon the needs of the customer.

LEAD TIME

General arrangement drawing — 6 weeks after Purchase Order

SHIPPING

Manufacturing will take place at Therma-Flite, Inc.'s Fabrication Facility, Benicia, CA. All components shall be shipped from 849 Jackson St., Benicia, CA 94510.

TERMS AND CONDITIONS OF SALE

1. Terms are cash unless otherwise agreed upon.
2. The fulfillment of all contracts, written or implied, is contingent upon strikes, lock-outs, governmental restrictions, accidents, shortage of material and other causes beyond our control.
3. Therma-Flite, Inc. products are guaranteed to be free from defects, both in material and workmanship, if and when used in the service for which they are intended and for which they are recommended by Therma-Flite, Inc., such guarantee to be effective for one (1) year from date of start-up.
4. Therma-Flite Inc.'s obligation and liability under this warranty is limited to the terms defined in Sections 16 and 17 above. Finished materials and accessories purchased from other manufacturers are warranted only to the extent of the original manufacturer's warranty. In no event shall liability hereunder exceed the amount of the invoice to the Owner for the item or items purchased. Returns must be authorized in writing to Therma-Flite, Inc.
5. Therma-Flite, Inc. will not be responsible for any damages, loss or expense incurred or contemplated, nor for labor or materials used in the alteration, correction or installation of Therma-Flite Inc.'s products, nor will Therma-Flite, Inc. be responsible for, nor accept charges for other materials used in conjunction with the system of which Therma-Flite Inc.'s product may be a part. This provision shall remain during the useful lifetime of Therma-Flite Inc.'s product.
6. All ratings and rating information shown are believed to be correct and true. Therma-Flite, Inc. assumes no responsibility for excessive fouling of the apparatus by material such as coke silt, scale or any other foreign substance that may be deposited, or for malfunction of the apparatus because of other conditions entirely beyond our control. Their function in accordance therewith, however, may be prevented or handicapped by conditions entirely beyond Therma-Flite, Inc.'s control. Therefore, performance is guaranteed by Therma-Flite, Inc. only in such cases as all working and/or services conditions are made

known to Therma-Flite, Inc. in writing by the purchaser and such guarantee reduced to writing. Any performance guarantees and potential liquidated damages are to be effective for a period of one (1) year from completion of startup.

7. Cancellation of orders cannot be accepted if the processing of the order has been started.

This **Purchase Order Agreement**, attached hereto represents the entire understanding between the Owner and Supplier and may only be modified in writing by both parties. If this **Purchase Order Agreement** is acceptable, please sign and date three copies in the space provided and return two copies to our office.

SUPPLIER:

Therma-Flite, Inc.
849 Jackson Street
Benicia, CA 94510

Signature

MIKE POTTER
Print Name

PRESIDENT
Title

3/18/10
Date

OWNER:

Bowling Green Municipal Utilities
801 Center Street
Bowling Green, KY 42102

Signature

MARK IVERSON
Print Name

GENERAL MANAGER
Title

3/25/10
Date

ATTACHMENT A

REQUEST FOR PROPOSALS

October 29, 2009

BOWLING GREEN MUNICIPAL UTILITIES

BOWLING GREEN, KENTUCKY

Wastewater Treatment Plant Expansion and Renovation

Biosolids Dryer System

BGMU Project No. S07-653

GS&P Project No. 26064.00

GRESHAM
SMITH AND
PARTNERS

TABLE OF CONTENTS

		NUMBER OF PAGES
SCOPE OF SUPPLY		2
PROPOSAL INSTRUCTIONS		15
PROPOSAL FORM		2
DETAILED SPECIFICATIONS		
DIVISION 1 – GENERAL REQUIREMENTS		
01 7823	Operation and Maintenance Data	7
	Routine Maintenance Schedule	1
DIVISION 40 – PROCESS INTEGRATION		
40 9990	Packaged Control System	18
DIVISION 44 – POLLUTION CONTROL EQUIPMENT		
44 4618	Indirect Dryer System	7
ATTACHMENTS		
Figure No. 1 - Biosolids Process Flow Diagram		1
Figure No. 2 – Enlarged Site Plan (West)		1
Figure No. 3 – Lower Level Floor Plan		1
Figure No. 4 – Section A		1
Bid Bond		2

SCOPE OF SUPPLY

Bowling Green Municipal Utilities (BGMU) is currently accepting proposals for a Biosolids Dryer System for the Wastewater Treatment Plant (WWTP) Expansion and Renovation project currently under construction. The Proposer shall provide a Biosolids Dryer System with all related appurtenances for a complete and operable system.

The WWTP expansion and renovation includes the addition of Sequencing Batch Reactors (SBRs). Waste-activated sludge (WAS) will be pumped from the SBRs to sludge holding tanks for thickening. The sludge holding tanks are designed to thicken the WAS to 0.8 - 1.5% solids which will then be pumped to the dewatering building. In the dewatering building, the thickened sludge will be dewatered by centrifuges to 15 - 18% solids prior to transport to a wet cake hopper. From the wet cake hopper, the biosolids shall be transported to the proposed dryer system or to containers for hauling to a landfill. The dried product will be stored in a silo utilized for dumping into containers for transport to final disposal location. The Biosolids Dryer System shall use continuous feed, indirect dryer technology. No other processes will be considered. See attached Figure 1 for process flow diagram.

The proposed dryer system shall operate under the following conditions:

- Dryer capacity shall be a minimum of 24 dry tons per operational day. The proposed dryer shall be capable of processing the solids given the input concentrations and operational times listed below. Operational hours include start up and shut down;
- Normal equipment operation shall be 24 hours per day, 5 days per week;
- Input (feed) solids concentrations are estimated to vary between 15 percent to 18 percent solids;
- Dryer system provided shall be capable of producing a dried product with a minimum of 90 percent solids; and,
- Given the operating conditions listed above, the dried product shall meet the requirements for Class A Biosolids as defined in *EPA Part 503 Biosolids Rule* for parameters controllable by the drying technology.

The equipment provided in this proposal shall consist of one complete and operational factory assembled solids dryer system and controls to process thickened biosolids dewatered by centrifuges.

A contractor representing BGMU will install the Biosolids Dryer System at the Bowling Green Municipal Utilities Wastewater Treatment Plant under supervision of Judy Construction Company serving as Construction Administrator. An electrical sub-contractor will connect the system components; however, control panel and equipment internal connections shall be made by the equipment manufacturer. The successful

Proposer must have a factory-authorized service representative on site during the installation and start-up of the dryer system and during any prescribed on-site operation and maintenance training for the Biosolids Dryer System as defined in the Request for Proposals.

PROPOSAL INSTRUCTIONS

1. Proposal Submittal Instructions

Proposals will be received by Bowling Green Municipal Utilities (hereafter called the "Owner"), at 801 Center Street, Bowling Green, Kentucky until 2:00 p.m. local time, November 19, 2009, and then at said location publicly opened and amounts indicated on the proposal forms subsequently read aloud. Proposals must be in the actual possession of Mr. Keith Williams, BGMU Purchasing Agent, on or prior to the exact time and date indicated above. Late proposals will not be considered.

Each proposal must be submitted in a sealed envelope, addressed to:

Mr. Keith Williams
BGMU Purchasing Agent
Bowling Green Municipal Utilities
801 Center Street
Bowling Green, Kentucky 42101.

Each sealed envelope containing a proposal must be plainly marked on the outside as **PROPOSAL FOR PROJECT NO. S07-653, Wastewater Treatment Plant Expansion and Renovation – Biosolids Dryer System.** The envelope shall bear on the outside the name and address of the Proposer. If forwarded by mail or other parcel delivery service, the sealed envelope containing the proposal must be enclosed in another envelope addressed to Bowling Green Municipal Utilities, 801 Center Street, P.O. Box 10300, Bowling Green, Kentucky 42102 to the attention of Mr. Keith Williams.

All proposals must contain the completed proposal form and required attachments listed herein. **FAILURE TO INCLUDE ALL REQUIRED ATTACHMENTS WILL RESULT IN DECLARATION OF PROPOSAL AS NON-RESPONSIVE AND THE REMOVAL OF THE PROPOSER FROM CONSIDSERATION.** Three copies of the proposal package must be submitted.

The Engineer is Gresham, Smith and Partners, 1400 Nashville City Center, 511 Union Street, Nashville, Tennessee 37219.

The Owner may waive any informalities or minor defects or reject any and all proposals. Any proposal may be withdrawn prior to the above scheduled time for the opening of proposals or authorized postponement thereof. Any proposal received after the time and date specified shall not be considered. No Proposer

may withdraw a proposal within 90 days after the actual date of the opening thereof. Should there be reasons why a purchase order cannot be issued by the Owner within the specified period; the time may be extended by mutual agreement between the Owner and the Proposer.

2. Proposal Content

Proposers must satisfy themselves of the system completeness by examination of this Request for Proposal including the specifications and any amendments issued. After proposals have been submitted, the Proposer shall not assert that there was a misunderstanding concerning the completeness of the system or of the nature of the system to be provided.

No items within these specifications are intended to eliminate any qualified Proposer. If the Proposer believes any item would prohibit proposing, contact Mike Burgett, P.E., Project Engineer, at the address given in the following paragraph or by telephone at (615) 770-8531 immediately.

If any person contemplating the submission of a proposal is in doubt as to the true meaning of any part of the specifications, he should submit a written request **no later than the deadline for questions as shown in the following Projected Timetable** for any interpretation thereof to:

Gresham, Smith and Partners
1400 Nashville City Center
511 Union Street
Nashville, Tennessee 37219
Attention: Mike Burgett, P.E., Project Engineer.

The person making the request shall be responsible for its prompt delivery. Any interpretation of the specifications will be made only by written amendment duly issued and mailed or delivered to each person receiving a set of such documents. All amendments so issued shall become part of the Request for Proposal and Contract Documents. The Owner and the Engineer will not be responsible for explanations or interpretations of the proposed documents except as issued in accordance herewith, and no verbal statement either before or after the execution of a Purchase Order shall affect or modify any of the terms or obligations contained herein.

Projected Timetable: The following projected timetable shall be used as a working guide for planning purposes. The Owner reserves the right to adjust this timetable as required during the course of the Request for Proposals process.

Projected Timetable

Request for Proposals Issued	October 29, 2009
Deadline for Equipment Pre-submittals	November 5, 2009
Deadline for Questions (3:00 pm Bowling Green Local Time)	November 9, 2009
Issue Amendment for Proposal Questions and for Listing Approved Manufacturers	November 12, 2009
Proposals Due (2:00 pm Bowling Green Local Time)	November 19, 2009
Evaluation of Proposals	November 25, 2009
Complete Contract Negotiations and Award Contract	ASAP

3. Proposal Package Requirements

Proposal packages shall contain three copies of the information described hereinafter along with the completed Proposal Form.

a. A list of any and all exceptions taken to the requirements of this Request for Proposal and any changes in the proposed installation drawing required by the proposer for proper installation of the proposed equipment and materials. Proposed equipment layouts shall include six feet clear space between equipment and all proposed building interior walls. Failure to provide this information will serve as the Proposer's agreement that the proposed biosolids dryer system can be furnished to meet the requirements of this Request for Proposal without modification.

b. Greenhouse Gas guarantee. The Mandatory Reporting of Greenhouse Gases (GHGs) rule requires reporting of annual emissions of carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), sulfur hexafluoride (SF_6), hydrofluorocarbons (HFCs), perfluorochemicals (PFCs), and other fluorinated gases. Facilities and suppliers that are subject to the rule must comply with the General Provisions (*40 CFR part 98, subpart A*) and the provisions of all other applicable subparts of *40 CFR 98*. Owners or operators of facilities that emit 25,000 metric tons or more of GHGs per year (expressed as carbon dioxide equivalents) from stationary fuel combustion or that meet any other applicability requirements of the rule are required to report emissions from stationary fuel combustion.

Stationary fuel combustion sources are devices that combust any solid, liquid, or gaseous fuel generally to:

- Produce electricity, steam, useful heat, or energy for industrial, commercial, or institutional use; or
- Reduce the volume of waste by removing combustible matter.

These devices include, but are not limited to boilers, combustion turbines, engines, incinerators, and process heaters. The rule excludes flares, portable equipment, emergency generators, emergency equipment, agricultural irrigation pumps, and combustion of hazardous waste. Facilities that contain stationary fuel combustion units, but do not contain a source in any other source category covered by the rule, are not required to submit a report if their aggregate maximum rated heat input capacity from all stationary fuel combustion units is less than 30 million British thermal units per hour (MMBTU/hr).

Proposer must supply a written guarantee that the proposed Biosolids Dryer System complies with EPA's *40 CFR 98* for reporting Greenhouse Gases. Additionally, if selected, Proposer shall supply Owner with an appropriate monitoring and recordkeeping process and shall aid in the first year of reporting.

c. Life cycle cost information to the extent and detail necessary for the Owner and Engineer to determine an accurate 20-year life cycle cost for the biosolids dryer system proposed. Any necessary life cycle cost information not submitted by the Proposer will be assumed by the Engineer based on previous life cycle cost information provided to the Engineer during the preliminary selection phase or engineering judgment. Neither the Engineer nor the Owner is responsible for the accuracy of any information assumed due to the lack of information submitted with the proposal package. <u>The minimum life cycle cost information required to be submitted is as follows and shall be submitted in tabular format</u>:

- Guaranteed minimum dry solids concentration in percent: Provide a written guarantee of the minimum percent of dry solids concentration achievable by the biosolids dryer system proposed to be furnished. Minimum percent solids, guaranteed above the required minimum 90 percent solids, will be considered when determining annual disposal costs.
- Natural Gas usage of complete biosolids dryer system in MMBTU per pound of water evaporated (MMBTU/lb H_2O evaporated) for the dryer and MMBTU/hr for ancillary equipment: Provide a list of all natural gas

equipment components, individual usage, and total natural gas usage. The Owner's natural gas usage cost is estimated at $10.29 per MMBTU.

- Electric usage of complete biosolids dryer system in kilowatt-hours (kW-hr): Provide a list of all electrical equipment components, individual electric usage, and total electrical usage. The Owner's electric usage cost is estimated at $0.08 cents per kW-hr.
- Water usage of the complete biosolids dryer system in gallons per minute (GPM) and the pressure required (PSI): Provide a list of all equipment requiring water (distinguish between reuse and potable water sources), water usage of individual components (distinguish between reuse and potable water sources), and total water usage (reuse and potable water). The estimated water usage for cleaning of equipment after use shall be noted, if applicable. The Owner's water usage cost is estimated at $2.40 per one thousand gallons.
- Annual maintenance cost of the complete biosolids dryer system: Provide a list of all maintenance items and costs associated with maintenance items.
- Recommended spare parts inventory and associated costs.
- Anticipated schedule and costs attributable to major equipment replacement or rebuild.

d. Classification requirements for all equipment. Proposals shall include costs for equipment and controls appropriate for the area classification. Additionally, classification requirements supplied by the Proposers shall be utilized during the evaluations to assess extra costs associated with added construction requirements due to equipment/area classifications.

e. Guaranteed time schedule for delivery of submittals after issuance of a purchase order and for shipment of the biosolids dryer system after receipt of submittals approved by the engineer.

f. Bid Bond payable to the Owner for five percent of the total amount of the base proposal. As soon as the proposals have been evaluated, the Owner will return the bonds of all except the three lowest responsible Proposers. When the Purchase Order is executed, the bonds of the two remaining unsuccessful Proposers will be returned. A certified check from a reputable and solvent financial institution may be used in lieu of a Bid Bond.

Attorneys in fact who sign Bid Bonds must file with each bond a certified and effective dated copy of their power of attorney.

The party to whom the Purchase Order is issued will be required to execute all documents within ten (10) calendar days from the date when the Purchase Order is delivered to the Proposer. In case of failure of the Proposer to execute the required documents within the allocated time frame, the Owner may at his option consider the Proposer in default, in which case the Bid Bond or Certified Check accompanying the proposal shall become the property of the Owner.

g. References for three comparable equipment installations located at a similar sized water or wastewater treatment facility. Installation locations in the United States are preferred. References shall include contact name, facility name, contact address, contact phone number and contact e-mail address.

h. Information describing and depicting the details of the equipment, controls, materials and services proposed to be provided. Information for the equipment, controls and materials described in this Request for Proposals must show, as a minimum, the following information:
   1) General layout of equipment with six-foot clear space from equipment to proposed building inside walls, complete engineering description, and performance characteristics;
   2) General installation and operational instructions (startup, running and shutdown);
   3) Natural Gas service connection location, size, and pressure requirement;
   4) Electrical service connection location and size requirement;
   5) Water service connection location, size, and pressure requirement;
   6) Any other connection locations and size requirements;
   7) Operational range diagrams;
   8) Manufacturer's rated efficiency, service factor, horsepower, normal full load amperes, maximum load ampere ratings, and voltage rating for all motors and for all devices powered by electric motors;
   9) List of spare parts and special tools (special tools shall be furnished by the Proposer as required by the nature of the equipment or as specifically called for in this Request for Proposals);
   10) Weight and load values at each equipment foundation support; and,
   11) Notation of coordination requirements.

***FAILURE TO INCLUDE ALL REQUIRED ATTACHMENTS WILL RESULT IN DECLARATION OF PROPOSAL AS NON-RESPONSIVE AND THE REMOVAL OF THE PROPOSER FROM CONSIDERATION.**

4. Proposers

The Owner may make such investigations as deemed necessary to determine the ability of the Proposer to execute the scope of work. The Proposer shall furnish to the Owner, at the Owner's request, information and data needed to satisfy the Owner's investigation into this matter. The Owner reserves the right to reject any proposal if the evidence submitted by, or investigation of, such Proposer fails to satisfy the Owner that such Proposer is properly qualified to carry out the obligations of the purchase order and to fulfill the scope of the work contemplated therein within the specified time.

Each Proposer is responsible for reading and being thoroughly familiar with all documents included in this request for proposal package. The failure or omission of any Proposer to do any of the foregoing shall in no way relieve any Proposer from any obligation in respect to his proposal.

5. Proposal Review and Award

The method of award will be the highest scoring evaluated proposal in accordance with procurement requirements stated in the Kentucky Revised Statutes, Pertaining to Model Procurement Code as adopted by Bowling Green Municipal Utilities. The applicable statute is KRS 45A.370. The evaluation criteria include life cycle cost, compliance with technical specifications, location of equipment service facilities, installation references and compliance with the requirements of this Request for Proposals. Life cycle cost comparison information required to be submitted for evaluation includes items listed at Paragraph 3.c. of this Request for Proposals and the total base quote for equipment provided on the Proposal Form. The maximum points assigned to each criteria and method of scoring shall be as listed in the following table.

Criteria	Maximum Points Available	Method of Scoring
Life Cycle Cost	50	Scores for Life Cycle Cost (20 Year Term) using 50 points for lowest life cycle cost proposal and 50 x (lowest life cycle cost / actual proposal's life cycle costs) for other proposals.
Compliance with Technical Specifications	25	Compliance with technical specifications is assigned 25 points. Points will be deducted for items included in proposals deemed by the review committee to present safety or operational issues. Each item will result in 5 point deductions.
Location of Equipment Service Facilities	10	10 points will be assigned to vendors with equipment service facilities* in the contiguous United States. 0 points will be assigned to vendors without equipment service facilities in the United States.
Installation References	15	5 points will be assigned for each favorable installation reference provided for comparable equipment in United States. 3 points will be assigned for each favorable installation reference provided outside the United States. A maximum of three references will be considered.

*Equipment service facility is defined as capable of providing qualified manpower, parts for service, and repair services.

If, at the time a purchase order is to be issued, the lowest evaluated proposal submitted by a responsible Proposer does not exceed the amount of funds estimated by the Owner as available to finance the purchase order; a purchase order will be issued on the **items as selected from the Proposal Form by the Owner**. The Owner reserves the right to reject any or all proposals or accept any combination of proposal and/or deductive or additive alternates; to waive any informality on proposals received; and to omit any item or items, deemed advisable for the best interests of the Owner, or to withhold final award of the order.

The Owner is authorized by permit to make tax free purchases as provided by the Commonwealth of Kentucky, Department of Revenue's regulations 103 KAR 30:225E.

6. Purchase Order

The Purchase Order is defined as a letter of intent sent to the Proposer from the Owner with associated Contract Documents of which each of the following form a part: this Request for Proposals with all attachments and the submitted proposal with all attachments. Information obtained from an officer, agent, or employee of the Owner or any other person shall not affect the risks or obligations assumed by the Proposer or relieve the Proposer from fulfilling any of the conditions of the Purchase Order.

7. Equipment Delivery Schedule

The quotation provided on the proposal form shall include all freight and delivery costs to the Bowling Green Municipal Utilities Wastewater Treatment Plant site (1189 Preston Avenue, Bowling Green, Kentucky 42101) and shall be valid until the estimated delivery date included in the request for proposal. The estimated delivery date for the equipment is October 2010. Upon award of the construction contract, the Owner's contractor will be required to submit a detailed construction schedule which will include the required delivery date for the equipment. Any revisions to the estimated delivery date will be transmitted to the Proposer at that time.

In the event the project is delayed for any reason and the equipment can not be delivered to the project site on the date provided by the Contractor, the Proposer shall store the equipment in a protected environment until delivery at the project site can be made. The Proposer may charge the Owner no more than the monthly fee provided in the proposal form for equipment storage. The time of storage will be from the required delivery date provided by the Contractor or the date the vendor notifies the Owner that the equipment is ready for shipment, whichever is later, to the date the Owner notifies the vendor that the equipment can be shipped to the project site. Partial months shall be billed on a prorated basis.

8. Approved Manufacturers

Manufacturers approved to submit Proposals are:

a. Andritz Separation, Inc.
   1010 Commercial Blvd. So.
   Arlington, TX 76001
   Attn: Bruce SoRelle
   Phone: (817) 419-1730
   Fax: (817) 419-1930
   Email: bruce.sorelle@andritz.com

b. I. Kruger, Inc.
   401 Harrison Oaks Boulevard
   Cary, North Carolina 27513
   Attn: Travis Smith
   Phone: (919) 653-4517
   Fax: (919) 677-0082
   Email: travis.smith@veoliawater.com

c. Komline-Sanderson
   12 Holland Avenue
   Peapack, NJ 07977-0257
   Attn: Jim Louden
   Phone: (908) 234-1000 x230
   Fax: (908) 234-9487
   E-mail: jalouden@komline.com

d. Therma-Flite, Inc.
   849 Jackson St.
   Benicia, CA 94510
   Attn: Preston Whitney
   Phone: (707) 747-5949
   Fax: (707) 747-5951
   E-mail: pwhitney@therma-flite.com

e. Or approved equal

Whenever the words "or approved equal" appear in this Request for Proposal or accompanying documents, they shall be interpreted to mean an item of material or equipment that, in the opinion of the Engineer, is similar to that named, suited to the same use, capable of performing the same function as that named, has a

record of service equal to that named, and is equal in quality, capacity and/or efficiency to that named.

In order to be approved as an equal for the purposes of this RFP, the Proposer must submit to the Project Engineer, Mike Burgett, P.E., all items requested by this RFP (except the proposal form and bonds) for review and approval no later than the date shown in the Projected Timetable as shown above in Item 2. Approved equal manufacturers shall be notified in writing by the Engineer that they have been approved and an amendment to this Request for Proposals shall be issued to all potential Proposers. The Engineer's decision as to the equality of any material or equipment to that specified shall be final, but the review of the Engineer shall not relieve the Proposer from his responsibility concerning such materials or equipment or affect the guarantee covering the workmanship, materials and equipment.

9. Submittals

After execution of the Purchase Order, the Proposer shall submit to the Owner a minimum of eight copies of information describing and depicting the details of the equipment, controls, materials and/or services to be provided. After approval, the Engineer will distribute the submittals as follows: two sets to Owner, one set to Engineer's central files, one set to Engineer's Resident Construction Observer, one set to Engineer's project manager, one set to the Contractor, one set to the Construction Administrator and one set to the Proposer. The Engineer will review up to nine sets of each submittal.

REJECTION OF THE SAME SUBMITTAL ON THREE SEPARATE OCCASIONS WILL CONSTITUTE GROUNDS FOR TOTAL REJECTION OF THE PROPOSER AS BEING UNABLE TO OR UNWILLLING TO MEET THE REQUIREMENTS OF THE REQUEST FOR PROPOSALS.

Submittals for the equipment, controls and materials described in this Request for Proposal must show, as a minimum, the following information or as described in the technical specification section entitled Biosolids Dryer System (Section 44 4618).

a. General layout, complete engineering description, and performance characteristics;
b. Manufacturer's written recommendations;
c. Manufacturer's product specifications;
d. Manufacturer's installation instructions;
e. Manufacturer's catalog cuts;

f. Wiring diagrams showing factory-installed wiring;
g. Operational range diagrams;
h. Lists of control system components including manufacturer's name and catalog number;
i. Detailed descriptive information such as copies of the manufacturer's catalog data for each control system component for control panels;
j. Manufacturer's rated efficiency, service factor, horsepower, normal full load amperes, and maximum load ampere ratings for all motors and for all devices powered by electric motors;
k. Capacity-head-efficiency-horsepower curves as specified for all pumps and compressors;
l. List of spare parts and special tools (special tools shall be furnished by the Proposer as required by the nature of the equipment or as specifically called for in this Request for Proposals);
m. General and detailed equipment and control layouts;
n. Anchor bolt setting and erection plans;
o. Weight and load values at each equipment foundation support;
p. Compliance with recognized trade association standards;
q. Compliance with recognized testing agency standards;
r. Application of testing agency labels and seals;
s. Factory test certifications;
t. Notation of coordination requirements;
u. Voltage rating of motors; and,
v. Equipment drive guards.

10. Operation and Maintenance Manual Requirements

After approval of submittals and a minimum of 60 days prior to installation and start-up of equipment, three bound copies of installation, operating and maintenance instructions shall be furnished to the Engineer. The Engineer shall return one copy of the draft manual and mark whether general scope and content of manual are acceptable. At least 15 days prior to final inspection of equipment, three bound copies of installation, operating and maintenance instructions with Engineer comments addressed, shall be provided along with an electronic version suitable for incorporation into Owner's electronic operation and maintenance manual system.

Additionally, the Owner requests one electronic copy, in AutoCAD, of the Record Electrical Drawings to be provided by the Proposer.

The information included in the Operation and Maintenance Manual shall be as listed in the attached Operation and Maintenance Data specification (Section 01 7823).

11. Start Up Services and Operator Training

The Proposer shall furnish and include in his price the services of a factory-authorized service representative. These services include verification of proper equipment installation and to start-up the equipment. The factory representative shall have complete knowledge of proper installation, operation, and maintenance of equipment supplied. The factory representative shall inspect the final installation and supervise a start-up test of the equipment. The Proposer shall include in his price a sufficient amount of on-site time for start-up services and plant operator operation and maintenance training. This on-site time is dependent upon the complexity of the equipment and may vary between Proposers; however, it shall be a minimum of two man-days on-site factory service during start-up and three man-days on-site service for operation and maintenance training. The on-site time does not include travel time. All travel expenses shall be included in the proposal price.

12. Certification of Installation

After installation and final testing of equipment, the equipment manufacturer shall make written certification to the Owner, Engineer and Contractor that the equipment and associated controls have been properly installed in accordance with the requirements of the Purchase Order, that this equipment installation will be warranted by the manufacturer as specified in this Request for Proposals, and that the Operation and Maintenance Manuals have been furnished to the Engineer.

13. Materials to be Provided by the Proposer

The Proposer shall provide all items named in this Request for Proposals or so noted on the Purchase Order and such incidental items as may be required for the safe and proper installation and operation of the equipment furnished for the purpose(s) intended.

The equipment described in this Request for Proposals shall be unloaded, stored and installed by a Contractor representing the Owner. The Contractor will only supply labor for installation, assistance with start-up and any grouting work required for installation.

The technical specifications for the proposed equipment are included in the attached Section 44 4618 Biosolids Dryer System.

14. Electrical Equipment Associated with Motors

In general, electrical equipment described in this Request for Proposals will be connected to the electrical system furnished and installed by an Electrical Subcontractor representing the Owner. **THE VENDOR SHALL BE RESPONSIBLE FOR ANY CHANGES IN ELECTRICAL EQUIPMENT CAUSED BY AN INCREASE IN HORSEPOWER. ANY CHANGES CAUSED BY SUCH AN INCREASE IN HORSEPOWER SHALL BE AT NO EXPENSE TO THE CONTRACTOR OR THE OWNER.**

15. Schedule and Liquidated Damages

The Proposer shall submit with his proposal a guaranteed time schedule for delivery of submittals after issuance of the Purchase Order and the equipment specified herein shall be delivered to the project site by the date specified in Item 7 above. If completion of the project is delayed due to failure to meet this delivery date, the Owner will suffer damages difficult to ascertain at this point, but agreed by both parties to be at least $500.00 per calendar day. Liquidated damages will be assessed to the Vendor in that amount for each calendar day after the equipment delivery date that the equipment is not delivered.

16. Payment Terms

The terms of payment for the equipment will be as follows:

5% Upon Approval of Submittals by Engineer
85% Upon Delivery or Certified Storage of Equipment
5% Upon Approval of Manufacturer's Start-up Report by Engineer
5% Upon Punch List Completion

17. Warranty

The equipment manufacturer shall provide a warranty against defective or deficient equipment, workmanship and materials under normal use, operation and service on all equipment and components provided in accordance with this Request for Proposals. Warranty includes on-site repair and/or replacement for all failed parts of system by the supplier. The warranty shall end a minimum of

one year from the date of equipment start-up or from date of Engineer's acceptance of the equipment for permanent operation, whichever is later. **Additional warranty beyond the one year minimum will be considered during the proposal evaluations.** The warranty shall be in printed form and apply to all similar units.

18. Attachments

The following attachments to this Request for Proposal will be incorporated into any Purchase Order issued in response to submitted proposals:

- Figure No. 1 - Biosolids Process Flow Diagram;
- Figure No. 2 – Enlarged Site Plan (West);
- Figure No. 3. – Lower Level Floor Plan;
- Figure No. 4. – Section A; and,
- Bid Bond.

END OF PROPOSAL INSTRUCTIONS

PROPOSAL FORM

Qty.	Description	Unit Price	Total Price
Base Quotation:			
1	Biosolids Dryer System	$	$
	Total Base Quote		$
Additive Alternate:			
1	Monthly Fee for Storage of Equipment at Proposer's Facility Past Required Delivery Date (Storage Includes Providing Insurance of Equipment While on Proposer's Property and Providing Certificate of Insurance to Owner)	$	$

Bowling Green Municipal Utilities reserves the right to accept or reject any or all of the above listed items.

Company: _____

Authorized Representative: _____
Print Name, Title

_____
Signature

Office Telephone Number: (____) _____

Office Fax Number: (____) _____

Mobile Telephone Number: (____) _____

Address: _____

_____

_____

E-mail Address: _____

Proposer has examined and carefully studied the Proposal Documents and the following Amendments, receipt of all which is hereby acknowledged (list each Amendment Number and Date):

Amendment Number	Amendment Date

Company Authorized Representative Initial here: _____

DETAILED SPECIFICATIONS

OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Request for Proposal, apply to this Section.

B. Related Sections include the following:
1. Division 40 Section "Package Control Systems".
2. Division 44 Section "Biosolids Dyer System".

1.2 SUMMARY

A. This Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:
1. Operation and maintenance documentation directory.
2. Emergency manuals.
3. Operation manuals for systems, subsystems, and equipment.
4. Maintenance manuals for the care and maintenance of systems and equipment.

1.3 DEFINITIONS

A. System: An organized collection of parts, equipment, or subsystems united by regular interaction.

B. Subsystem: A portion of a system with characteristics similar to a system.

1.4 SUBMITTALS

A. Initial Submittal: Submit three draft copies of each manual 60 days prior to equipment installation and start-up. Include a complete operation and maintenance directory. Engineer will return one copy of draft and mark whether general scope and content of manual are acceptable.

B. Final Submittal: Submit three copies of each manual in final form at least 15 days before final inspection. Engineer will return copy with comments after final inspection, if required.
1. Correct or modify each manual to comply with Engineer's comments. Submit three paper copies and three electronic copies of each corrected manual within 15 days of receipt of Engineer's comments. Files on CD copies should be in PDF format.

1.5 COORDINATION

A. Where operation and maintenance documentation includes information on installations by more than one factory-authorized service representative, assemble and coordinate information furnished by representatives and prepare manuals.

© 2009 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 2 - PRODUCTS

2.1 OPERATION AND MAINTENANCE DOCUMENTATION DIRECTORY

A. Organization: Include a section in the directory for each of the following:
   1. List of documents.
   2. List of systems.
   3. List of equipment.
   4. Table of contents.

B. List of Systems and Subsystems: List systems alphabetically. Include references to operation and maintenance manuals that contain information about each system.

C. List of Equipment: List equipment for each system, organized alphabetically by system. For pieces of equipment not part of system, list alphabetically in separate list.

D. Tables of Contents: Include a table of contents for each emergency, operation, and maintenance manual.

E. Identification: In the documentation directory and in each operation and maintenance manual, identify each system, subsystem, and piece of equipment with same designation used in the proposal and submittals.

2.2 MANUALS, GENERAL

A. Organization: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:
   1. Title page.
   2. Table of contents.
   3. Manual contents.

B. Title Page: Enclose title page in transparent plastic sleeve. Include the following information:
   1. Subject matter included in manual.
   2. Name and address of Project.
   3. Name and address of Owner.
   4. Date of submittal.
   5. Name, address, and telephone number of Contractor.
   6. Name and address of Engineer.
   7. Cross-reference to related systems in other operation and maintenance manuals.

© 2009 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

C. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.
   1. If operation or maintenance documentation requires more than one volume to accommodate data, include comprehensive table of contents for all volumes in each volume of the set.

D. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.
   1. Binders: Heavy-duty, 3-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, sized to hold 8-1/2-by-11-inch (215-by-280-mm) paper; with clear plastic sleeve on spine to hold label describing contents.
      a. If two or more binders are necessary to accommodate data of a system, organize data in each binder into groupings by subsystem and related components. Cross-reference other binders if necessary to provide essential information for proper operation or maintenance of equipment or system.
      b. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL," Project title or name, and subject matter of contents. Indicate volume number for multiple-volume sets.
   2. Dividers: Plastic dividers with tabs for each section. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Project Manual.
   3. Protective Plastic Sleeves: Transparent plastic sleeves designed to enclose diagnostic software diskettes for computerized electronic equipment and for storing compact discs containing electronic version of the complete manual.
   4. Supplementary Text: Prepared on 8-1/2-by-11-inch (215-by-280-mm) white bond paper.
   5. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.
      a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
      b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.

2.3 EMERGENCY MANUALS

A. Content: Organize manual into a separate section for each of the following:
   1. Type of emergency.
   2. Emergency instructions.
   3. Emergency procedures.

© 2009 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Type of Emergency: Where applicable for each type of emergency indicated below, include instructions and procedures for each system, subsystem, piece of equipment, and component:
   1. Fire.
   2. Flood.
   3. Gas leak.
   4. Water leak.
   5. Power failure.
   6. Water outage.
   7. System, subsystem, or equipment failure.
   8. Chemical release or spill.

C. Emergency Instructions: Describe and explain warnings, trouble indications, error messages, and similar codes and signals. Include responsibilities of Owner's operating personnel for notification of Installer, supplier, and manufacturer to maintain warranties.

D. Emergency Procedures: Include the following, as applicable:
   1. Instructions on stopping.
   2. Shutdown instructions for each type of emergency.
   3. Operating instructions for conditions outside normal operating limits.
   4. Required sequences for electric or electronic systems.
   5. Special operating instructions and procedures.

2.4 OPERATION MANUALS

A. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:
   1. System, subsystem, and equipment descriptions.
   2. Performance and design criteria if Contractor is delegated design responsibility.
   3. Operating standards.
   4. Operating procedures.
   5. Operating logs.
   6. Manufacturer's certified prints.
   7. Wiring diagrams.
   8. Control diagrams.
   9. Piped system diagrams.
   10. Precautions against improper use.
   11. License requirements including inspection and renewal dates.

B. Descriptions: Include the following:
   1. Product name and model number.
   2. Manufacturer's name and name, address, and phone number of manufacturer's representative.
   3. Equipment identification with serial number of each component.
   4. Equipment function.
   5. Equipment major dimensions and cross-section views.

© 2009 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

6. Operating characteristics.
7. Limiting conditions.
8. Performance curves.
9. Engineering data and tests.
10. Complete nomenclature and number of replacement parts.

C. Operating Procedures: Include the following, as applicable:
1. Startup procedures.
2. Equipment or system break-in procedures.
3. Routine and normal operating instructions.
4. Regulation and control procedures.
5. Instructions on stopping.
6. Normal shutdown instructions.
7. Seasonal and weekend operating instructions.
8. Required sequences for electric or electronic systems.
9. Special operating instructions and procedures.

D. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.

E. Piped Systems: Diagram piping as installed, and identify color-coding where required for identification.

2.5 SYSTEMS AND EQUIPMENT MAINTENANCE MANUAL

A. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranty and bond information, as described below.

B. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual.

C. Manufacturers' Maintenance Documentation: Manufacturers' maintenance documentation including the following information for each component part or piece of equipment:
1. Standard printed maintenance instructions and bulletins.
2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
3. Identification and nomenclature of parts and components.
4. List of items recommended to be stocked as spare parts.

© 2009 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

D. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:
   1. Test and inspection instructions.
   2. Troubleshooting guide.
   3. Precautions against improper maintenance.
   4. Proper cleaning methods of equipment and specific components of equipment.
   5. Disassembly; component removal, repair, and replacement; and reassembly instructions.
   6. Aligning, adjusting, and checking instructions.
   7. Demonstration and training videotape, if available.

E. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.
   1. Scheduled Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semiannual, annual, and bi-annual frequencies on the routine maintenance schedule provided at the end of this Section.
   2. Maintenance and Service Record: Include manufacturers' forms for recording maintenance.

F. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.

G. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent, if applicable.

H. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
   1. Include procedures to follow and required notifications for warranty claims.

PART 3 - EXECUTION

3.1 MANUAL PREPARATION

A. Operation and Maintenance Documentation Directory: Prepare a separate manual that provides an organized reference to emergency, operation, and maintenance manuals.

B. Emergency Manual: Assemble a complete set of emergency information indicating procedures for use by emergency personnel and by Owner's operating personnel for types of emergencies indicated.

C. Operation and Maintenance Manuals: Assemble a complete set of operation and maintenance data indicating operation and maintenance of each system, subsystem, and piece of equipment not part of a system.

© 2009 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.
3. Warranties and Bonds:
   a. Except for items put into use with Owner's permission, leave date of beginning of warranty until Date of Substantial Completion is determined.
   b. Verify that documents are in proper form, contain full information, and are notarized.
   c. Co-execute documents when required.

D. Manufacturers' Data: Where manuals contain manufacturers' standard printed data, include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.
   1. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.

E. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in manufacturer's certified prints to ensure correct illustration of completed installation.
   1. Do not use Project Record Documents as part of operation and maintenance manuals.

F. Provide complete manual in Portable Document Format (PDF) in addition to paper format.

END OF SECTION 01 7823

© 2009 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

Routine Maintenance Schedule

Maintenance Description	Daily	Weekly	Monthly	Semi-annually	Annually	Bi-annually

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of this Request for Proposals apply to this Section.

B. Related Sections include the following:
   1. Division 44 Section "Indirect Dryer System".

1.2 SUMMARY

A. This Section describes the package control system requirements for the Biosolids Drying System.

B. Assemble panels and install instruments, plumbing, and wiring in equipment manufacturer's factories.

C. Test panels and panel assemblies for proper operation prior to shipment from equipment manufacturer's factory.

1.3 DEFINITIONS / REFERENCES

A. The following is a list of standards which may be referenced in this Section:
   1. Instrumentation, Systems, Automation Society (ISA): S50.1, Compatibility of Analog Signals for Electronic Process Instruments.
   2. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. AB 1, Molded Case Circuit Breakers and Molded Case Switches.
      c. ICS 2, Industrial Control Devices, Controllers and Assemblies.
   3. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
   4. Underwriters Laboratories Inc. (UL): 508A, Standards for Safety, Industrial Control Panels.

1.4 SUBMITTALS

A. Submittals:
   1. Bill of material, catalog information, descriptive literature, wiring diagrams, and Shop Drawings for components of control system.
   2. Catalog information on electrical devices furnished with system.
   3. Shop Drawings, catalog material, and dimensional layout drawings for control panels and enclosures.
   4. P&ID showing entire system including instruments and 1/0. Tag all components shown on the P&ID.

© 2009 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

5. Panel elementary diagrams of prewired panels. Include in diagrams control devices and auxiliary devices, for example, relays, alarms, fuses, lights, fans, and heaters.
6. Plumbing diagrams of pre-plumbed panels and interconnecting plumbing diagrams.
7. Interconnection wiring diagrams that include numbered terminal designations showing external interfaces.
8. Test Plan: Submit test plan before scheduling a factory test.
9. Software Emulation and Data Integration Development Plan for Ethernet Network connected PLCs: Submit plan for emulation of data exchange between package system and Plant SCADA system. Data exchange shall be emulated at the Factory Acceptance Test (FAT).

B. Informational Submittals:
   1. Programmable Controller Submittals:
      a. Complete set of user manuals.
      b. Fully documented ladder logic listings.
      c. Function listing for function blocks not fully documented by ladder logic listings.
      d. Cross-reference listing.
   2. Application Software Submittals:
      a. Submit annotated data exchange tables that list all READ/WRITE bits and words with corresponding PLC addresses for approval. These tables must meet the plant computer system data exchange requirements.
      b. Submit examples of graphic displays developed for the local operator interface.
      c. Submit examples of ladder logic for key process sequences.
   3. Manufacturer's list of proposed spares, expendables, and test equipment.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Delivery, storage, and handling of the equipment shall be as stated in Item 7 of the Proposal Instructions listed in the Request for Proposals.

B. Prior to shipment, include corrosive-inhibitive vapor capsules in shipping containers and related equipment as recommended by capsule manufacturer.

1.6 EXTRA MATERIALS

A. Spares, Expendables, and Test Equipment:
   1. Selector Switch, Pushbutton, and Indicating Light: 10 percent, one minimum, of each type used.
   2. Light Bulb: 20 percent, 2 minimum, of each type used.
   3. Fuse: 20 percent, 5 minimum, of each type used.
   4. Surge Suppressors: 20 percent, one minimum, of each type used.

© 2009 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 2 - PRODUCTS

2.1 SIGNAL CHARACTERISTICS

A. Analog Signals:
1. 4 to 20 mA, in accordance with compatibility requirements of ISA S50.1.
2. Unless otherwise specified or shown, use Type 2, two-wire circuits.
3. Transmitters: Load resistance capability conforming to Class L.
4. Fully isolate input and output signals of transmitters and receivers.

B. Pulse Frequency Signals: dc pulses whose repetition rate is linearly proportional to process variable over 10:1 range. Generate pulses by contact closures or solid-state switches.
1. Power source: Less than 30V dc.

C. Discrete Signals:
1. Two-state logic signals.
2. Utilize 120V ac sources for control and alarm signals.
3. Alarm signals shall be normally open, close to alarm isolated contacts rated for 5-ampere at 120V ac and 2-ampere at 30V dc.

2.2 CORROSION PROTECTION

A. Corrosion-Inhibiting Vapor Capsule Manufacturers:
1. Northern Technologies International Corporation; Model Zerust VC.
2. Hoffmann Engineering; Model A-HCI.
3. Or approved equal

2.3 CONTROL PANEL

A. Panel Construction and Interior Wiring: In accordance with the National Electrical Code (NEC), UL 508, state and local codes, and applicable sections of NEMA, ANSI, and ICECA.

B. Conform to NEMA ratings as specified in individual equipment sections.

C. Minimum Metal Thickness: 14-gauge.

D. All panels shall be NEMA 250, Type 4X Panels: Type 316 stainless steel construction, unless otherwise specified.

E. Doors:
1. Three-point latching mechanisms in accordance with NEMA 250 Type I and 12 panels with doors higher than 18 inches.
2. For other doors, stainless steel quick release clamps or three-point latching mechanisms.

© 2009 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

F. Cutouts shall be cut, punched, or drilled and finished smoothly with rounded edges.

G. Access: Front, suitable for installation with back and sides adjacent to or in contact with other surfaces, unless otherwise specified.

H. Temperature Control:
   1. Size panels to adequately dissipate heat generated by equipment mounted on or in the panel.
   2. Furnish cooling fans with air filters if required to dissipate heat.
   3. For panels outdoors or in unheated areas, furnish thermostatically controlled heaters to maintain temperature above 40 degrees F.

I. Heat Exchangers/Air Conditioning for NEMA 4X Outdoor Panels: For NEMA 4X panels mounted outdoors, evaluate heat generated inside the panel taking into account all components. Provide internal circulating fans, heat exchangers and/or air conditioning, to limit panel internal temperature to 90 degrees F with ambient temperatures of 120 degrees F. NEMA 4X rating shall not be compromised as a result of heat exchanging systems. Outdoor panel location is subject to Engineer review.

J. Push-to-Test Circuitry: For each push-to-test indicating light, provide a fused push-to-test circuit.

K. Lighting: Minimum of one hand switch controlled internal 100-watt fluorescent light for panels.

L. Minimum of one 120-volt GFCI duplex receptacle for panels 12 cubic feet and larger.

M. Finish:
   1. Metallic External Surfaces (Excluding Aluminum and Stainless Steel): Manufacturer's standard gray unless otherwise specified.
   2. Internal Surfaces: White enamel.
   3. Provide manufacturer's electrostatically applied TGIC polyester powder coat white paint for all aluminum and stainless steel panels that will be mounted outdoors.

N. Panel Manufacturers:
   1. Hoffman.
   2. Rittal.
   3. Saginaw.
   4. Or approved equal.

O. Breather and Drains: Furnish with NEMA 250, Type 4 and 4X panels.
   1. Manufacturer and Product: Cooper Crouse-Hinds; ECD Type 4X Drain and Breather; Drain Model ECDI-N4D, Breather Model ECDI-N4B, or approved equal.

© 2009 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2.4 CONTROL PANEL ELECTRICAL

A. UL Listing Mark for Enclosures: Mark stating "Listed Enclosed Industrial Control Panel" per UL 508A.

B. I&C and electrical components, terminals, wires, and enclosures UL recognized or UL listed.

C. Control Panels without Motor Starters or Drives:
   1. Furnish main circuit breaker and a circuit breaker on each individual branch circuit distributed from power panel.
   2. Locate to provide clear view of and access to breakers when door is open. Group on single subpanel. Provide typed directory.
   3. Circuit Breakers:
      a. Coordinate for fault in branch circuit trips, branch breaker, and not main breaker.
      b. Branch Circuit Breakers: 15 amps at 250V ac.

D. Control Panels with Three-Phase Power Supplies, Motor Starters, Variable Frequency Drives (VFDs), and/or DC-SCR Drives:
   1. Interlock main circuit breaker with panel door.
      a. Mount logic controls, branch circuit breakers, overload reset switches, and other control circuit devices.
      b. Mount operator controls and indications on front access door.
   2. Circuit Breakers:
      a. In accordance with NEMA AB I.
      b. 22,000-ampere RMS symmetrical rating, minimum at 480 volts, unless otherwise specified.
      c. Breakers, except Motor Branch Breakers: Molded case thermal magnetic.
      d. 22,000-ampere RMS symmetrical rating, minimum at 480 volts, unless otherwise specified in package system equipment specification sections.
      e. Tripping: Indicate with operator handle position.
   3. Magnetic Motor Starters:
      a. Full voltage, NEMA ICS 2, Class A, Size 0 minimum.
      b. Include three-pole bimetallic or eutectic alloy thermal overload relays sized for each motor.
      c. Manual reset type with reset button mounted on panel door.
   4. Motor Control: 120V ac (except intrinsically safe circuits where applicable).
      a. Power Control Transformer:
         1) Sufficient capacity to serve connected load, including 200 VA for duplex outlet plus l00 VA (minimum).
         2) Limit voltage variation to 15 percent during contact pickup.
         3) Fuse one side of secondary winding and ground the other.
         4) Furnish primary winding fuses in ungrounded conductors.
   5. DC-SCR Drives: As specified in individual process specifications.

© 2009 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

6. Power Monitoring Relay:
   a. Protect three-phase equipment from single phasing, phase imbalance, or phase reversal.
   b. Separate, isolated contact outputs to stop motors and activate alarm light during abnormal conditions.
   c. Transient Voltage Protection: 10,000 volts.
   d. Manufacturer and Product: Furnas; Class 47 or equal.
7. Power Distribution Blocks: Furnish to parallel feed tap on branch circuit protective devices. Do not "leap frog" power conductors.
8. Terminations for Power Conductors: Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

E. Wiring:
1. ac Circuits:
   a. Type: 600-volt, Type MTW stranded copper.
   b. Size: For current to be carried, but not less than 14 AWG.
2. Analog Signal Circuits:
   a. Type: 300-volt, Type 2 stranded copper, twisted shielded pairs.
   b. Size: 18 AWG, minimum.
3. Other dc Circuits.
   a. Type: 600-volt, Type MTW stranded copper.
   b. Size: 18 AWG, minimum.
4. Separate analog and other dc circuits at least 6 inches from any ac power and control wiring.
5. Enclose wiring in sheet metal raceways or plastic wiring ducts.
6. Wire Identification: Numbered and tagged at each termination.
   a. Wire Tags: Machine printed, heat shrink.

F. Wiring Interface:
1. For analog and discrete signal, terminate at numbered terminal blocks.
2. For special signals, terminate power (240 volts or greater) at manufacturer's standard connectors.
3. For panel, terminate at equipment on/with which it is mounted.

G. Terminal Blocks:
1. Quantity:
   a. For external connections.
   b. Wire spare or unused panel mounted elements to their panels' terminal blocks.
   c. Spare Terminals: 20 percent of connected terminals, but not less than 10.
2. General: Group to keep 120V ac circuits separate from 24V dc circuits.
   a. Connection Type: Screw connection clamp.
   b. Compression Clamp:
      1) Hardened steel clamp with transversal grooves penetrating wire strands providing a vibration-proof connection.
      2) Guides strands of wire into terminal.

© 2009 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

c. Screws: Hardened steel, captive, and self-locking.
d. Current Bar: Copper or treated brass.
e. Insulation:
    1) Thermoplastic rated for minus 55 to plus 110 degrees C.
    2) Two funnel shaped inputs to facilitate wire entry.
f. Mounting:
    1) Rail.
    2) Terminal block can be extracted from an assembly without displacing adjacent blocks.
    3) End Stops: One at each end of rail, minimum.
g. Wire Preparation: Stripping only.
h. Jumpers: Allow jumper installation without loss of space on terminal or rail.
i. Marking System:
    1) Terminal number shown on both sides of terminal block.
    2) Allow use of preprinted and field marked tags.
    3) Terminal strip numbers shown on end stops.
    4) Mark terminal block and terminal strip numbers as shown.

3. Terminal Block, 120-Volt Power:
    a. Rated Voltage: 600V ac.
    b. Rated Current: 30 amps.
    c. Wire Size: 22 through 10 AWG.
    d. Rated Wire Size: 10 AWG.
    e. Color: Gray body.
    f. Spacing: 0.25 inch, maximum.
4. Terminal Block, Ground:
    a. Wire Size: 22 through 12 AWG.
    b. Rated Wire Size: 12 AWG.
    c. Color: Green and yellow body.
    d. Spacing: 0.25 inch, maximum.
    e. Grounding: Ground terminal blocks electrically grounded to mounting rail.
5. Terminal Block, Blade Disconnect Switch:
    a. Use: Provide one for each discrete input and output field interface wire.
    b. Rated Voltage: 600V ac.
    c. Rated Current: 10 amps.
    d. Wire Size: 22 through 12 AWG.
    e. Rated Wire Size: 12 AWG.
    f. Color: Gray body, orange switch.
    g. Spacing: 0.25 inch, maximum.
6. Terminal Block, Fused, 24V dc:
    a. Rated Voltage: 600V dc.
    b. Rated Current: 6.3 amps.
    c. Wire Size: 22 through 12 AWG.
    d. Rated Wire Size: 12 AWG.
    e. Color: Gray body.
    f. Fuse: 5 by 20 GMA fuses.

© 2009 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

g. Fuse Marking: Fuse amperage rating shown on top of terminal block.
h. Indication: LED diode 24V dc.
i. Leakage Current: 5.2 mA, maximum.
j. Spacing: 0.32 inch, maximum.

7. Terminal Block, Fused, 120V ac:
   a. Rated Voltage: 600V ac.
   b. Rated Current: 6.3 amps.
   c. Wire Size: 22 through 12 AWG
   d. Rated Wire Size: 12 AWG.
   e. Color: Gray body.
   f. Fuse: 5 by 20 GMA fuses.
   g. Fuse Marking: Fuse amperage rating shown on top of terminal block.
   h. Indication: Neon lamp 110V ac.
   i. Leakage Current: 1.8 mA, maximum.
   j. Spacing: 0.32 inch, maximum.

H. Grounding: Internal copper grounding bus for ground connections on panels, consoles, racks, and cabinets. Signal ground and electrical safety ground must be connected together to form a single point ground within the panel. All metallic panel enclosures shall be bonded to the ground bus.

I. Relays:
   1. General:
      a. Relay Mounting: Plug-in type socket.
      b. Relay Enclosure: Provide dust cover.
      c. Socket Type: Screw terminal interface with wiring.
      d. Socket Mounting: Rail.
      e. Furnish hold down clips.
   2. Control Circuit Switching Relay, Non-latching:
      a. Type: Compact general purpose plug-in.
      b. Contact Arrangement: 3 Form C contacts.
      c. Contact Rating: l0A at 28V dc or 240V ac.
      d. Contact Material: Silver cadmium oxide alloy.
      e. Coil Voltage: As noted or shown.
      f. Coil Power: 1.8 watts (dc), 2.7VA (ac).
      g. Expected Mechanical Life: 10,000,000 operations.
      h. Expected Electrical Life at Rated Load: 100,000 operations.
      i. Indication Type: Neon or LED indicator lamp.
      j. Push-to-test button.
   3. Control Circuit Switching Relay, Latching:
      a. Type: Dual coil mechanical latching relay.
      b. Contact Arrangement: 2 Form C contacts.
      c. Contact Rating: 10A at 28V dc or 120V ac.
      d. Contact Material: Silver cadmium oxide alloy.
      e. Coil Voltage: As noted or shown.
      f. Coil Power: 2.7 watts (dc), 5.3VA (ac).

© 2009 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

g. Expected Mechanical Life: 500,000 operations.
h. Expected Electrical Life at Rated Load: 50,000 operations.

4. Control Circuit Switching Relay, Time Delay:
   a. Type: Adjustable time delay relay.
   b. Contact Arrangement: 2 Form C contacts.
   c. Contact Rating: 10A at 240V ac.
   d. Contact Material: Silver cadmium oxide alloy.
   e. Coil Voltage: As specified or shown.
   f. Operating Temperature: Minus 10 to 55 degrees C.
   g. Repeatability: Plus or minus 2 percent.
   h. Delay Time Range: Select range such that time delay setpoint falls between 20 to 80 percent or range.
   i. Time Delay Set Point: As specified or shown.
   j. Mode of Operation: As specified or shown.
   k. Adjustment Type: Integral potentiometer with knob external to dust cover.

J. Intrinsic Safety Barriers:
   1. Provide as shown on Drawings and as required by NFPA 70 (National Electric Code) for hazardous locations as designated by the Engineer and NFPA 820.
   2. Install in accordance with the National Electric Code.
   3. Provide UL listed Intrinsically Safe Relays and Intrinsically Safe Barriers selected based on the entity parameters of the associated instrument or device.
   4. Intrinsically Safe Relays: Monitor discrete signals that originate in hazardous area and are used in a safe area.
      a. Manufacturers:
         1) MTL.
         2) Stahl.
         3) Or equal.
   5. Intrinsically Safe Barriers: Interface analog signals as they pass from hazardous area to safe area.
      a. Manufacturers:
         1) MTL.
         2) Stahl.
         3) Or equal.

K. Programmable Logic Controllers:
   1. General:
      a. Provide PLCs meeting the following minimum requirements unless otherwise noted in specific package specification sections.
      b. Function: Used for process monitoring and control by emulating functions of conventional panel mounted equipment such as relays, timers, counters, current switches, calculation modules, PID controllers, stepping switches, and drum programmers.
      c. Type: Microprocessor based device programmable using ladder logic.

© 2009 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

d. Parts: Central processing unit (CPU), power supply, local and remote input/output modules, local and remote base (chassis/rack) controllers, I/O bases (chassis/rack), data highway, and factory assembled interconnecting cables. Provide components required to make a complete and totally operational system.

2. Environmental:
   a. Temperature: Operating range 32 to 140 degrees F (0 to60 degrees C); storage range minus 40 to 158 degrees F (0 to70 degrees C).
   b. Humidity: Operating range 5 to 95 percent non-condensing.
   c. Vibration:
      1) Sinusoidal: IEC 68-2-6, Test Fe; 0.15 mm peak-to-peak, 10-to 57-Hz; I g, 57-to 150-Hz.
      2) Random: IEC 68-2-34, Test Fdc; 0.4 g%/Hz, 80-to 350-Hz, and 3dB/octave rolloff, 80-to 20-Hz and 350-to 2-KHz at 10 min/axis.
   d. Noise: IEC 801, Part 3, Level 3 and Part 4, Level 3;MIL STD-461B.
   e. Isolation: User-side to PLC side 1,500V rms.
3. Central Processing Unit (CPU):
   a. Type: Microprocessor, 16-bit minimum.
   b. Scan Time: Less than I ms/K words of relay ladder logic.
   c. PLC Communications:
      1) Minimum 1 serial and one Ethernet communication port for communication with Owner's SCADA System.
   d. Instruction Set:
      1) Timers and Counters: minimum 256, minimum timer resolution 0.1 seconds; minimum counter count range 0 to32,000.
      2) Math: Signed integer and floating-point math including add, subtract, multiply, divide, square root, and compare.
      3) Register Operations: Shift registers, bit shift, bit set, bit clear, data move and data format conversion.
      4) Process Loop Control: User configurable direct or reverse acting PID loop control computation with the capability of both AUTO and MANUAL modes of operation, remote access to controller tuning constants; minimum of 16 PID loops.
      5) Real Time Clock: Date and time set and compare.
   e. Diagnostics:
      1) Indicators: Battery status, PLC status, PLC operation mode, remote FO communication status.
      2) Status Word: With failure status for PLC battery, scan overrun, communications, 1/0, special functions.
      3) Power Up: PLC checks status of PROMs upon power up; runs self-diagnostics on power-up; periodically runs self-diagnostics while in RUN mode, halts logic processor and sets outputs to configured state if fatal error is detected.
      4) Diagnostic Tables: Tables, displayable by programming computer, that describe nature and location (address) existing faults and errors.

© 2009 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

f. Agency Approvals and Standards:
   1) UL listed.
   2) CSA certified.
   3) DIN Standard 41494.
   4) IEC-65A/WG6 draft proposal.
   5) Factory Mutual approved.

4. Random Access Memory (RAM):
   a. Type: CMOS type.
   b. Word Size: 16 bits, minimum.
   c. Battery Backup: 1 month, minimum.
   d. Memory Size: Sufficient to implement all applications software plus 50 percent spare.
   e. Memory Size: 8 K words of ladder logic memory, 2 K words of variable memory, plus required overhead for standard functions.
   f. Read only memory (ROM) for controller's operating system and diagnostics.
   g. Compact flash for non-volatile program storage.
5. Power Supply: One unit for each input/output base assembly:
   a. Voltage: 120/220 volts (user selectable), 60-Hz input; 85 to132 volts output.
6. Input/Output: Complete input/output system.
   a. Discrete Input Modules:
      1) Voltage: 120 volts, 60-Hz.
      2) Operating Power: 2 watts.
      3) Points per Module: 16 maximum.
      4) LED status indicator for each point.
      5) Isolation: Between input point and PLC, 1,500 volts rms
   b. Discrete Output Modules:
      1) Voltage: 120 volts, 60-Hz.
      2) Operating Power: 2 watts.
      3) Load Rating: 2 amps continuous.
      4) Isolation: Between PLC and output point, 1,500 volts rms.
      5) Points per Module: 16 maximum.
      6) LED status indicator for each point.
   c. Analog Input/Output Modules:
      1) Voltage: 24 volts dc.
      2) Power: 3 watts.
      3) Differential Analog Points Per Module: 8 maximum.
      4) Isolated Analog Output Points Per Module: 8 maximum.
      5) Isolation: Between PLC and 1/0 point and between 1/0points, 1,500 volts rms.
   d. Pulse Input Modules:
      1) Input Voltage: 5V or 12-24V (user selectable).
      2) Input Current: 7 mA at 5V; 7.0 to 1.5 mA at 12-24V.
      3) Points per Module: 4, maximum.
      4) Maximum Input Frequency: 100 KHz in counter mode.
      5) Maximum Count Value: 0-999,999 (programmable).

© 2009 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

7. Identification: Nameplates installed above/below each PLC component (CPU, 1/0 rack, power supply).
8. The PLC System shall be as manufactured by the following manufacturer complete with compatible 110 modules, racks, power supplies as required to meet the system requirements:
   a. Allen-Bradley; ControlLogix.
   b. Or prior approved equal.

L. Front-of-Panel Devices in Conjunction with NEMA 250, Type 1 and 12 Panels:
1. Potentiometer Units:
   a. Three-terminal, oiltight construction, resolution of 1 percent and linearity of plus or minus 5 percent.
   b. Single-hole, panel mounting accommodating panel thicknesses between 1/8 and 1/4 inch.
   c. Include legend plates with service markings.
   d. Manufacturers and Products:
      1) Allen-Bradley; Model 800T.
      2) Or approved equal.
2. Indicating Lights:
   a. Push-to-test type, LED, oiltight, industrial type with integral full voltage 24 V dc.
   b. Screwed on prismatic glass lenses in colors noted and factory engraved legend plates for service legend.
   c. Manufacturers and Products:
      1) Allen Bradley Model 800T.
      2) Or approved equal.
3. Pushbutton, Momentary:
   a. Heavy-duty, oiltight, industrial type with full guard and momentary contacts rated for 10 amperes continuous at 120V ac.
   b. Standard size legend plates with black field and white markings for service legend.
   c. Manufacturers and Products:
      1) Allen Bradley.
      2) Or approved equal.
4. Selector Switch:
   a. Heavy-duty, oiltight, industrial type with contacts rated for120V ac service at 10 amperes continuous.
   b. Standard size, black field, legend plates with white markings, for service legend.
   c. Operators: Black knob type.
   d. Single-hole mounting, accommodating panel thicknesses from1/16 inch to 1/4 inch.
   e. Manufacturers and Products for Units with up to Four Selection Positions:
      1) Allen Bradley.
      2) Or approved equal.

© 2009 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

f. Manufacturers and Products for Units with up to 12 Selection Positions:
   1) Rundel-Idec; Standard Cam Switch.
   2) Electroswitch; 31.
   3) Or approved equal.

M. Front-of-Panel Devices Used in Conjunction with NEMA 250, Type 4XPanels:
1. Potentiometer, Watertight:
   a. Three-terminal, heavy-duty NEMA 250, Type 4X watertight construction, resolution of 1 percent and linearity of plus or minus 5 percent.
   b. Single-hole, panel mounting accommodating panel thicknesses between 1/8 and 1/4 inch.
   c. Include engraved legend plates with service markings.
   d. Manufacturer and Product: Allen-Bradley; Bulletin 800H or approved equal.
2. Indicating Lights, Watertight:
   a. Heavy-duty, push-to-test type, LED, NEMA 250, Type 4X watertight, industrial type for 24V dc applications and corrosion-resistant service.
   b. Screwed on prismatic lenses and factory engraved legend plates for service legend.
   c. Manufacturers and Products:
      1) Square D; Type SK.
      2) Allen-Bradley; Type 800H.
      3) Or approved equal.
3. Pushbutton, Momentary, Watertight:
   a. Heavy-duty, NEMA 250, Type 4X watertight, industrial type with momentary contacts rated for 120V ac service at 10 amperes continuous and corrosion-resistant service.
   b. Standard size, black field, legend plates with white markings for service legend.
   c. Manufacturers and Products:
      1) Square D; Type SK.
      2) Allen-Bradley; Type 800H.
      3) Or approved equal.
4. Selector Switch, Watertight:
   a. Heavy-duty, NEMA 250, Type 4X watertight, industrial type with contacts rated for 120V ac service at 10 amperes continuous and corrosion-resistant service.
   b. Standard size, black field, legend plates with white markings, for service legend.
   c. Operators: Black knob type.
   d. Single-hole mounting, accommodating panel thicknesses from 1/16 to 1/4 inch.
5. Manufacturer and Products:
   1) Square D; Class 9001, Type SK.
   2) Allen-Bradley; Type 800H.
   3) Or approved equal.

© 2009 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

2.5 INSTRUMENT TAG NUMBERS

A. Tag all instruments and package system components to conform with Engineer's tag numbering convention. Where applicable, use Engineer-provided tag numbers as shown on Drawings.

2.6 NAMEPLATES, NAMETAGS, AND SERVICE LEGENDS

A. Nametags: Permanently mounted bearing entire ISA tag number.
   1. Panel Mounted: Plastic, mounted to instrument behind panel face.
   2. Field Mounted: Engraved Type 316 stainless steel, 22-gauge minimum thickness, attached with stainless steel.

B. Service Legends (Integrally Mounted with Instrument) and Nameplates:
   1. Engraved, rigid, laminated plastic type with adhesive back. Furnish service legends and nameplates to adequately describe functions of panel face mounted instruments.
   2. Color: White with black letters.
   3. Letter Height: 3/16 inch.
   4. For each panel, face mounted laminated nameplate inscribed with the panel name and tag number. Color shall be white with black letters1/2 inch high.

2.7 HARDWARE DOCUMENTATION FOR ETHERNET NETWORK CONNECTED PLC'S

A. All Ethernet connections shall be coordinated with Revere Control Systems for system compliance.

B. Provide the following for all elements of the PLC:
   1. Block Diagram: A diagram showing all major system components. Identify components by manufacturer and model number. Show interconnecting cables diagrammatically.
   2. Bill-of-Materials: A list of all PLC components. Group components by type and include:
      a. Component manufacturer, model number, and part number.
      b. Component description.
      c. Quantity supplied.
      d. Reference to component catalog information.
   3. Descriptive Information: Catalog information, descriptive literature, performance specifications, internal wiring diagrams, power and grounding requirements, power consumption, and heat dissipation of all elements of the PLC system. Clearly mark all options and features proposed for this Project.
   4. Interconnecting Wiring Diagrams: Diagrams shall show all PLC elements, their interconnecting cables and wiring terminations, and all terminations to all interacting elements and subsystems. Terminations shall be numbered. Terminations for circuits extending outside PLC assemblies and/or leaving panels shall be labeled with circuit names corresponding to the Circuit and

© 2009 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

Raceway Schedule. The external circuit portion of this diagram shall be coordinated with the Electrical Subcontractor and shall bear his mark showing that this work has been done.

5. Outline Drawings: Equipment envelope Drawings showing external dimensions, enclosure materials, conduit connections, and installation requirements.
6. Installation Details: Any modifications or further details as may be required to supplement the Purchase Order Documents and adequately define the installation of the PLC elements.
7. Input/Output List: For each I/O point, list point type, tag number of the source or final control element, equipment description, PLC number, PLC terminal identification, rack number, module slot number, and PLC address.

2.8 APPLICATION SOFTWARE FOR ETHERNET NETWORK CONNECTED PLC'S

A. All Ethernet connections shall be coordinated with Revere Control Systems for system compliance.

B. PLC Application Software Development Methodology: The programmable controller system (PLC) is required to communicate over a fiber optic data link with HMI servers and other PLCs to be provided by others. It is extremely important that each PLC is programmed in a way that allows elegant data exchange between the HMI, other PLCs, and this PLC. Coordinate data communication with the HMI applications programmer.
   1. All control and monitoring features of the package system HMI shall be available over the Plant SCADA control system.
   2. PLC shall be programmed using ladder logic.
   3. Provide annotated data exchange look up tables and other information to allow the HMI applications programmer to implement efficient data exchange between HMI and PLC.

C. The data exchange table must be submitted for approval with the Emulation and Data Integration plan.

D. Software Design Submittal: This submittal shall be a detailed description on the application program. Submit this material during the program development stage. Provide ladder logic programs to implement all functional requirements specified in applicable process specifications. This submittal shall be reviewed by the Engineer prior to the submittal of the Preliminary Software Documentation.

E. Preliminary Software Documentation; Provide this submittal at least 4 weeks prior to the Factory Test. Here the term "preliminary" refers only to the timing of this submittal, not the level of detail to be provided. This submittal shall be a fully detailed version of all the material described hereinafter under Paragraph O&M Manual, Paragraph Software Documentation, except that the CD disc copies are not required at this time.

© 2009 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

F. Provide format of reports to be generated by HMI using data received from the PLC. Provide any required calculation procedures.

2.9 EXCEPTIONS TO ETHERNET CONNECTION REQUIREMENTS FOR PLCS

A. For certain package systems that do not include a PLC or include a Micro PLC with no provision for Ethernet connection, a prior approval of the Owner is mandatory. Provide specific reasons explaining why the Ethernet connection cannot be provided. If such request is granted, then the Supplier shall include provision for hard wiring of analog and digital signals to the Owner's SCADA System.

2.10 ELECTRICAL SURGE AND TRANSIENT PROTECTION

A. General:
1. Function: Protect elements of PICS against damage due to electrical transients induced in interconnecting lines by lightning and nearby electrical systems.
2. Implementation: Provide, install, coordinate, and inspect grounding of surge suppressors at:
   a. Connection of ac power to PICS equipment including panels, console assemblies, and field mounted analog transmitters and receivers.
   b. At the field and panel, console, or assembly connection of signal circuits including analog and data lines.
3. Construction: First-stage high energy metal oxide varistor and second-stage bipolar silicon avalanche device separated by series impedance. Includes grounding wire, stud, or terminal.
4. Response: 5 nanoseconds maximum.
5. Recovery: Automatic.
6. Temperature Range: Minus 20 degrees C to plus 85 degrees C.

B. Suppressor Locations:
1. At point of connection between each equipment item, including ac powered transmitters and its power supply conductors (direct wired equipment).
2. On analog pairs at each end when the pair travels outside of building.
3. In other locations where equipment sensitivity to surges and transients requires additional protection beyond that inherent to design of equipment.

C. Suppressors on 120V ac Power Supply Connections:
1. Occurrences: Tested and rated for a minimum of 50 occurrences of IEEE 587 Category B test waveform.
2. First-Stage Clamping Voltage: 350 volts or less.
3. Second-Stage Clamping Voltage: 210 volts or less.
4. Continuous Operation:
   a. Power supplies for one four-wire transmitter or receiver: 5 amps minimum at 130V ac.
   b. All other applications: 30 amps minimum at 130V ac.

© 2009 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

D. Power Supply Suppressor Assemblies:
   1. Suitable for connection to 120-volt, single-phase power supplies under15 amps EDCO "HSP SERIES" or approved equal.
   2. Suitable for connection to 120-volt, single-phase power supplies over15 amps EDCO "IL SERIES" or approved equal.
   3. Suitable for connection to 480-volt, three-phase power supplies; Square D J9200-9A or EDCO "IL SERIES" or approved equal.

E. Suppressors on Analog Signal Lines:
   1. Test Waveform: Linear 8 microsecond rise in current form 0 amp to a peak current value followed by an exponential decay of current reaching one-half the peak value in 20 microseconds.
   2. Surge Rating: Tested and rated for 50 occurrences of 2,000-amp peak test waveform.
      a. dc Clamping Voltage: 20 to 40 percent above operating voltage for circuit.
      b. dc Clamping Voltage Tolerance: Less than plus or minus10 percent.
      c. Maximum Loop Resistance: 18 ohms per conductor.

F. Physical Characteristics:
   1. Mounted in Enclosures: Encapsulated inflame retardant epoxy.
   2. For all Analog Signals Lines: EDCO PC-642 or SRA-64 series or approved equal.
   3. Field Mounted at Two-Wire Instruments: Encapsulated in stainless steel pipe nipples. EDCO SS64 series or approved equal.
   4. Four-Wire Instruments: With 120V ac outlet, ac circuit breaker, including surge suppressor for signal as well as 120V power line, all in enclosure. EDCO SLAC series or approved equal.

G. Installation and Grounding of Suppressors: As shown. See Surge Suppressor Installation Details. Coordinate surge suppressor grounding in field panels and field instrumentation with electrical contractor, and surge suppressor manufacturer's requirements. Furnish control panels with an integral copper grounding bus for connection of suppressors and other required instrumentation.

2.11 O&M MANUALS

A. Hardware:
   1. Provide the Following:
      a. Updated versions of all material described under paragraph Hardware Documentation.
      b. Component Manufacturers' O&M Manuals: Include manuals to cover installation, operation, maintenance, troubleshooting, and calibration.
      c. List of spare parts and expendables provided and list of spare parts recommended.

© 2009 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. Software:
   1. Provide the Following:
      a. Programming Manuals: Component manufacturers' standard programming manuals.
      b. Software Documentation: Provide a final version of the material called for under Paragraph Software Design Submittal.

PART 3 - EXECUTION (Not Used)

END OF SECTION 40 9990

© 2009 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Request for Proposal, apply to this Section.

B. Related Sections include the following:
1. Division 01, Section "Operation and Maintenance Data" for administrative and procedural requirements for preparing operation and maintenance manuals.
2. Division 40, Section "Packaged Control System" for requirements on the control system regarding panels and instrumentation.

1.2 SUMMARY

A. This Section includes the complete indirect dryer system. Equipment and all appurtenances will be installed by others, as recommended by the manufacturer, and in compliance with all OSHA, local, state and federal codes and regulation.

B. All equipment included in this section shall be furnished by a single supplier who shall be responsible for the design, coordination, and satisfactory operation of the system.

C. Any re-design required to accommodate the Owner for an approved equal proposal shall be borne by the equipment manufacturer/supplier.

1.3 DEFINITIONS / STANDARDS

A. American Iron and Steel Institute (AISI):
1. 316 Stainless Steel.

B. American National Standards Institute (ANSI)

C. American Society of Mechanical Engineers (ASME)

D. American Society for Testing and Materials (ASTM)

E. American Welding Society (AWS).

F. Code of Federal Regulations, Part 503 – Standards For The Use Or Disposal Of Sewage Sludge (40 CFR 503)

G. Code of Federal Regulations, Part 98 – Mandatory Reporting of Greenhouse Gases (40 CFR 98)

H. Institute of Electrical and Electronics Engineers (IEEE)

I. National Electric Code (NEC)

© 2009 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

J. National Electrical Manufacturers Association (NEMA)

K. National Fire Protection Association (NFPA)

L. Occupational Safety and Health Administration (OSHA)

M. Programmable Logic Control (PLC)

N. Supervisory Control And Data Acquisition (SCADA)

1.4 SUBMITTALS

A. Proposal package requirements shall be as stated in Item 3 of the Proposal Instructions listed in the Request for Proposal.

B. Submittals shall be as stated in Item 9 of the Proposal Instructions listed in the Request for Proposal.

C. At the time of submission, the manufacturer shall, in writing, call the Owner's and Engineer's attention to any deviations that the submittal may have from the requirements of these Specifications.

D. All materials submitted for review shall be contained in one submission. Partial submittals will not be reviewed. Sales bulletins or other general publications are not acceptable for review, except where necessary to provide supplemental technical data.

E. Performance affidavit.

F. A complete written description of the warranty to be provided.

1.5 QUALITY ASSURANCE

A. The indirect dryer system shall be the product of a recognized manufacturer whose personnel have been regularly engaged in the design and manufacturing of such equipment. The manufacturer must be able to demonstrate experience with the design, fabrication, supply, and successful operation of an indirect dryer of similar size and capacity. The manufacturer/supplier shall demonstrate upon the request of the Engineer that:
   1. They maintain a reasonable stock of spare parts for this equipment.
   2. They employ sufficient qualified technical personnel to insure adequate servicing and operational control advice.

B. Provide a list of references (name, location and contact information) of at least three operating installations currently using the same or similar model proposed located in the United States, if available.

© 2009 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

C. Performance Test:
   1. If the performance testing indicates noncompliance with the requirements of this specification, the indirect dryer system shall be re-worked and retested at the manufacturer's expense until compliance with the specification is attained.

D. All parts of the equipment provided to be designed and manufactured for long, continuous and uninterrupted service. All materials used to be of best quality and entirely suitable for service required.

E. Identification: The specified system shall be identified with a corrosion-resistant nameplate, securely affixed in a conspicuous location. Nameplate information shall include equipment model number, serial number, and supplier's name and location.

1.6 DELIVERY, STORAGE AND HANDLING

A. Delivery, storage and handling of the equipment shall be as stated in Item 7 of the Proposal Instructions listed in this Request for Proposal.

B. Ship items as complete assemblies except where partial disassembly is required by transportation regulations or for protection of components.

C. Protect equipment during storage and shipment in accordance with the manufacturer's recommendations.

D. Spare Parts: Packed in containers, labeled clearly with part number, designating contents, and pieces of equipment.

1.7 WARRANTIES AND BONDS

A. The warranty for the equipment shall be as stated in Item 17 of the Proposal Instructions listed in this Request for Proposal.

B. Manufacturer's Certificate: The indirect dryer manufacturer will submit to the Engineer and Owner, a written report certifying that the equipment has been satisfactorily installed.

PART 2 - PRODUCTS

2.1 GENERAL

A. The BGMU WWTP expansion and renovation includes the addition of Sequencing Batch Reactors (SBRs). Waste-activated sludge (WAS) will be pumped from the SBRs to sludge holding tanks for thickening. The sludge holding tanks are designed to thicken the WAS to 0.8 - 1.5% solids which will then be pumped to the dewatering building. In the dewatering building, the thickened sludge will be dewatered by centrifuges to 15 - 18% solids prior to transport to a wet cake hopper for storage.

© 2009 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

From the wet cake hopper, biosolids shall be transported by progress cavity pump to dumpsters for hauling to a landfill or to the proposed dryer system. The dried product shall be stored in a silo which is utilized for dumping into containers for transport to final disposal location.

B. Method of heating shall be indirect, meaning the heating medium is not in contact with the product being heated. No other systems will be considered.

C. Dryer system shall be capable of producing a dried product with a minimum of 90 percent solids and meet requirements for Class A Biosolids as defined in *EPA Part 503 Biosolids Rule* for parameters controllable by the drying technology, given the operating conditions provided in the Request for Proposals.

D. The indirect dryer shall comply with EPA's 40 CFR, Part 98, Subpart A for regulations on the mandatory reporting of greenhouse gases.

2.2 ACCEPTABLE MANUFACTURERS

A. Andritz Separation, Inc., of Arlington, TX.

B. I. Kruger, Inc., of Cary North Carolina.

C. Komline-Sanderson, of Peapack, NJ.

D. Therma-Flite, Inc., of Benicia, CA.

E. Or approved equal.

2.3 SYSTEM REQUIREMENTS

A. The indirect dryer system shall include the following as a minimum:
1. Indirect dryer;
2. Thermal oil heater (if applicable);
3. Cooling screw or dry product cooling system;
4. Control Panel that ties into existing SCADA system;
5. Condenser / Scrubber (if applicable);
6. Odor Control;
7. Dust Collection System of Fines Classification System to minimize dust;
8. Heat Recovery System (if applicable);
9. Instrumentation, Sampling Points, and Controls;
10. Air Compressor (if applicable);
11. Necessary Valves;
12. All other appurtenances for a complete system.

© 2009 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. The wet cake discharged from the centrifuges will be conveyed to a wet cake hopper. From the wet cake hopper, the biosolids are pumped into the indirect dryer with a progressive cavity-type pump. The progressive cavity pumps are sized for 35 gpm at 60 psi and will operate in a duty/standby configuration.

C. Equipment manufacturer shall provide monitoring capabilities as follows:
   1. For motors 15 hp and above:
      a. Voltage;
      b. Amps; and
      c. Kw-hours.
   2. For motors 500 hp and above:
      a. Voltage;
      b. Amps;
      c. Bearing temperature;
      d. Vibration; and
      e. Kw-hours.

2.4 PERFORMANCE REQUIREMENTS

A. Design Criteria:

1.	Method:	Automated, indirect heated, continuous flow dehydration system
2.	Maximum Number of Dryers:	2
3.	Minimum Throughput:	24 dtpd
4.	Solids In (%):	15 – 18
5.	Solids Out (%):	≥ 90
6.	Maximum Biosolids Production	
	a. Summer (dtpd):	16
	b. Winter (dtpd):	18
	c. Average (dtpd):	17
7.	Run Time	
	a. Hours /Day:	24
	b. Days /Week:	5
8.	Maximum Water Requirements	
	a. Potable Water (gpm):	20
	b. Plant Effluent (gpm):	500
9.	Product Temperature:	< 120 deg. F. exiting product cooler
10.	Odor Control	
	a. Peak H_2S Loading (ppm):	50
	b. Removal Efficiency (%):	99
11.	Final Product Particle Size:	1 - 4 mm $\pm$ 5%

B. Performance Testing:
   1. Performance testing shall be completed during the start-up period and include personnel representing the Owner.
   2. The performance tests shall be conducted in accordance with the requirements of 40 CFR Part 503.

© 2009 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

3. Test shall consist of a minimum of three (3) tests and shall be performed over a minimum of eight (8) hours. All tests shall be averaged to demonstrate compliance with specified performance criteria.
4. Owner will give acceptance after three consecutive tests meet the performance guarantees listed herein.
5. Sampling and testing costs shall be the responsibility of the equipment manufacturer.

2.5 MATERIALS OF CONSTRUCTION

A. Indirect dryer to utilize 316 stainless steel components to prevent corrosion.

B. Flanges, other than structural connections, shall be ANSI B16, class 150 type, raised face, slip-on weld.

2.6 CONTROL SYSTEM

A. Control Enclosures shall be stainless steel, NEMA 4X, UL labeled.

B. Control System shall comply with Division 40, Section "Packaged Control Systems".

C. PLC:
1. System shall be automated so that PLC does not require a dedicated full time employee.
2. The PLC Control Panel shall include the necessary input/output (I/O), capabilities as recommended by the equipment manufacturer.

D. SCADA: The SCADA system shall provide feedback information on system components, alarms, historical trending, and allow the operator to modify set points. SCADA system shall communicate via Ethernet.

E. The dryer should provide controls for operation of the wet cake hopper, with live bottom, and the wet cake pumps.

F. Typical Field Instruments include:
1. Pressure Indicating Transmitter
2. Pressure Gauge with Diaphragm Seal
3. Level Probe
4. Temperature Switch
5. Magnetic Flow Meter with Transmitter

2.7 START-UP AND TRAINING SERVICES

A. Upon completion of the indirect dryer installation and at a time designated by the Owner, the services of one factory service engineer shall be provided for a period of not less than five (5) days to start-up equipment, complete performance testing, and train Owner's personnel in the operation and maintenance of the equipment furnished.

© 2009 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

B. At least five (5) months after start-up, indirect dryer manufacturer will perform diagnostic review of system to guarantee system is performing as specified. System will be evaluated on overall efficiency. If at this time the system is in non-compliance with manufacturer's standards, system shall be re-worked, at manufacturer's expense, until compliance is achieved.

2.8 PAINTING

A. Steel fabrications shall be sand blasted and coated with one (1) coat of zinc rich primer and a minimum of 3 mils of corrosion resistant coating.

B. Any defects or damage caused in manufacturing will be thoroughly cleaned, wire brushed, wiped clean with a suitable solvent and dried. The prepared area shall be coated with a zinc rich compound specifically formulated for wet environments. The zinc rick coatings shall be a minimum of 3 mils thick and will be in accordance with SSPC standards.

2.9 SPARE PARTS

A. Manufacturer's recommendation of spare parts.

PART 3 - EXECUTION (Not Used)

END OF SECTION 44 4618

© 2009 Gresham, Smith and Partners. All rights reserved. Use subject to any written agreement with Gresham, Smith and Partners.

ATTACHMENTS

PENAL SUM FORM

BID BOND

Any singular reference to Bidder, Surety, Owner, or other party shall be considered plural where applicable.

BIDDER (Name and Address):

SURETY (Name and Address of Principal Place of Business):

OWNER (Name and Address):

BID
Bid Due Date:
Project (Brief Description Including Location):

BOND
Bond Number:
Date (Not later than Bid due date):
Penal sum _____ _____
(Words) (Figures)

Surety and Bidder, intending to be legally bound hereby, subject to the terms printed on the reverse side hereof, do each cause this Bid Bond to be duly executed on its behalf by its authorized officer, agent, or representative.

BIDDER	SURETY
_____ (Seal)	_____ (Seal)
Bidder's Name and Corporate Seal	Surety's Name and Corporate Seal
By: _____	By: _____
Signature and Title	Signature and Title (Attach Power of Attorney)
Attest: _____	Attest: _____
Signature and Title	Signature and Title

Note: Above addresses are to be used for giving required notice.

1. Bidder and Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors and assigns to pay to Owner upon default of Bidder the penal sum set forth on the face of this Bond. Payment of the penal sum is the extent of Surety's liability.

2. Default of Bidder shall occur upon the failure of Bidder to deliver within the time required by the Bidding Documents (or any extension thereof agreed to in writing by Owner) the executed Agreement required by the Bidding Documents and any performance and payment bonds required by the Bidding Documents.

3. This obligation shall be null and void if:

3.1. Owner accepts Bidder's Bid and Bidder delivers within the time required by the Bidding Documents (or any extension thereof agreed to in writing by Owner) the executed Agreement required by the Bidding Documents and any performance and payment bonds required by the Bidding Documents, or

3.2. All Bids are rejected by Owner, or

3.3. Owner fails to issue a Notice of Award to Bidder within the time specified in the Bidding Documents (or any extension thereof agreed to in writing by Bidder and, if applicable, consented to by Surety when required by Paragraph 5 hereof).

4. Payment under this Bond will be due and payable upon default by Bidder and within 30 calendar days after receipt by Bidder and Surety of written notice of default from Owner, which notice will be given with reasonable promptness, identifying this Bond and the Project and including a statement of the amount due.

5. Surety waives notice of any and all defenses based on or arising out of any time extension to issue Notice of Award agreed to in writing by Owner and Bidder, provided that the total time for issuing Notice of Award including extensions shall not in the aggregate exceed 120 days from Bid due date without Surety's written consent.

6. No suit or action shall be commenced under this Bond prior to 30 calendar days after the notice of default required in Paragraph 4 above is received by Bidder and Surety and in no case later than one year after Bid due date.

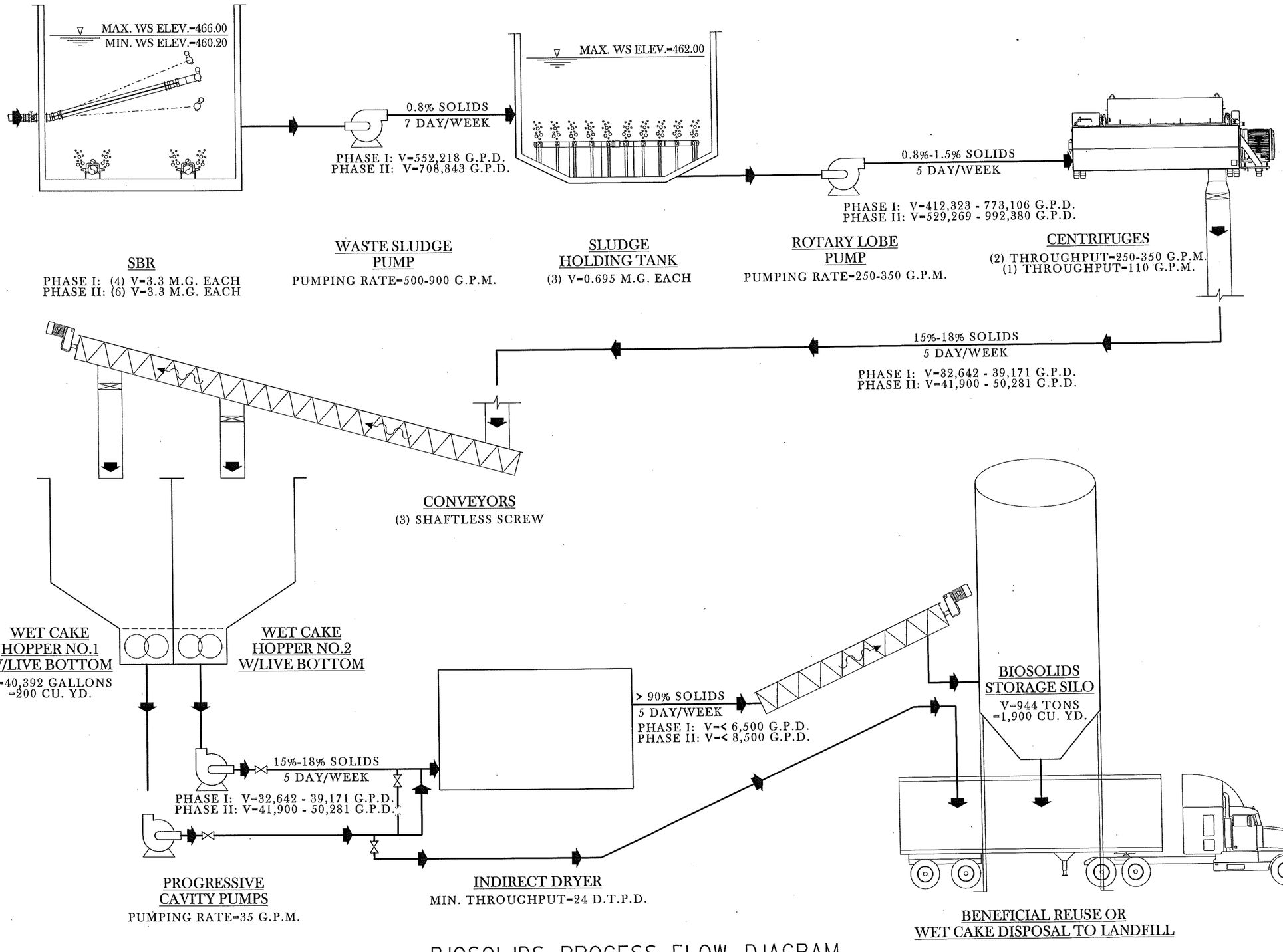
7. Any suit or action under this Bond shall be commenced only in a court of competent jurisdiction located in the state in which the Project is located.

8. Notices required hereunder shall be in writing and sent to Bidder and Surety at their respective addresses shown on the face of this Bond. Such notices may be sent by personal delivery, commercial courier, or by United States Registered or Certified Mail, return receipt requested, postage pre-paid, and shall be deemed to be effective upon receipt by the party concerned.

9. Surety shall cause to be attached to this Bond a current and effective Power of Attorney evidencing the authority of the officer, agent, or representative who executed this Bond on behalf of Surety to execute, seal, and deliver such Bond and bind the Surety thereby.

10. This Bond is intended to conform to all applicable statutory requirements. Any applicable requirement of any applicable statute that has been omitted from this Bond shall be deemed to be included herein as if set forth at length. If any provision of this Bond conflicts with any applicable statute, then the provision of said statute shall govern and the remainder of this Bond that is not in conflict therewith shall continue in full force and effect.

11. The term "Bid" as used herein includes a Bid, offer, or proposal as applicable.



BIOSOLIDS PROCESS FLOW DIAGRAM

SCALE: N.T.S.

PRELIMINARY - For Review Only

G S & P

Design Services For The Built Environment

Atlanta
Birmingham
Charlotte
Cincinnati
Columbus
Dallas
Fort Lauderdale
Jacksonville
Louisville
Memphis
Nashville
Richmond
Tampa

GRESHAM SMITH AND PARTNERS

WWW.GSPNET.COM

WASTEWATER TREATMENT PLANT EXPANSION AND RENOVATION

CONTRACT 3

BIOSOLIDS DRYER SYSTEM ADDITION

BOWLING GREEN MUNICIPAL UTILITIES

Warren County
Bowling Green, Kentucky

BGMU Project No. S07-653

REVISION		
No. -	Date -	Revision

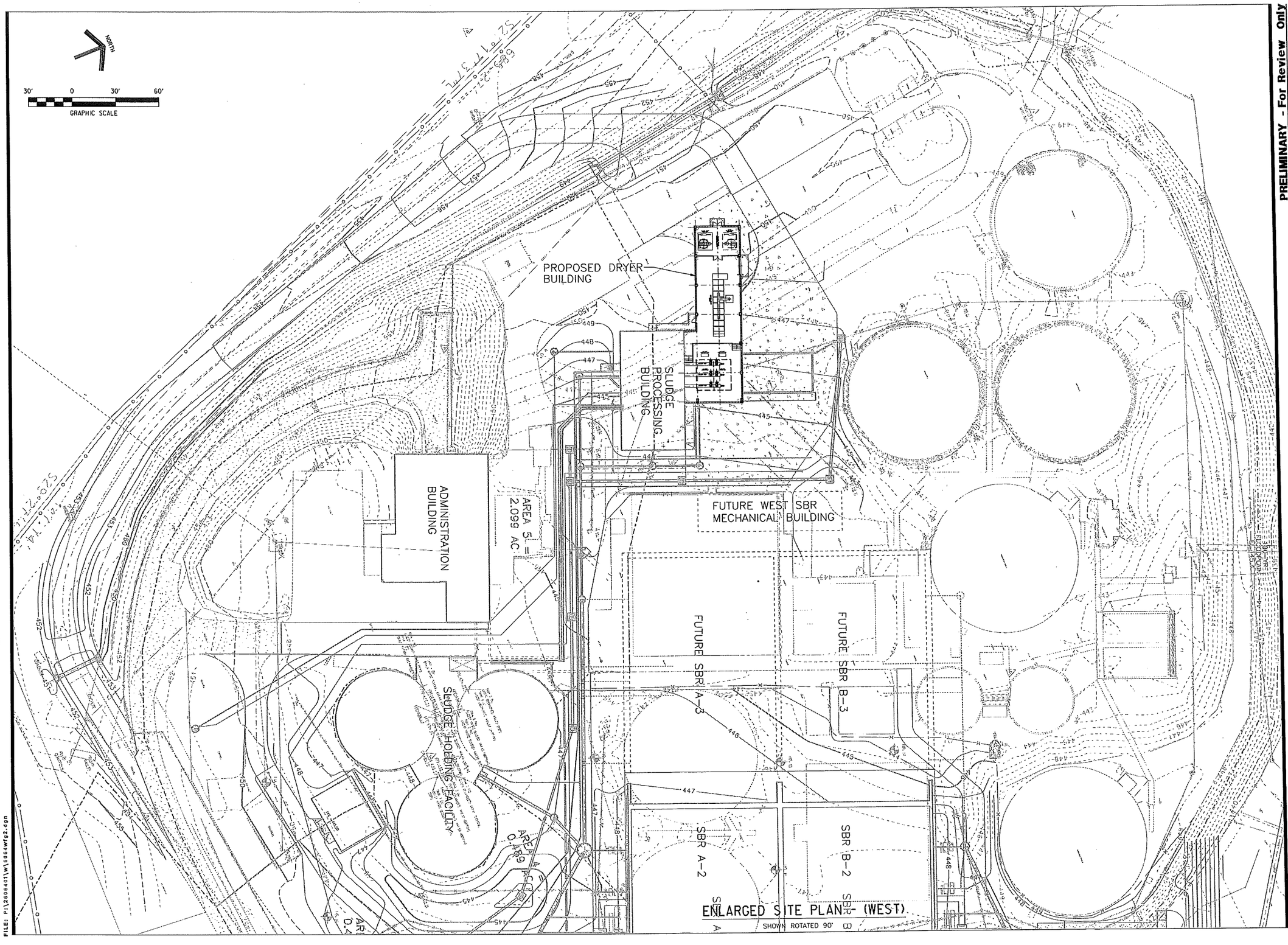
REQUEST FOR PROPOSAL
BIOSOLIDS DRYER SYSTEM ADDITION

FIGURE NO:

1

PROJECT: 26064.01
DATE: OCTOBER 2009

dbrot
FILE: P:\26064.01\W\26064wfg1.dgn
B.O.



PRELIMINARY - For Review Only

GS&P

Design Services For The Built Environment

Atlanta
Birmingham
Charlotte
Cincinnati
Columbus
Dallas
Fort Lauderdale
Jacksonville
Louisville
Memphis
Nashville
Richmond
Tampa

GRESHAM SMITH AND PARTNERS

WWW.GSPNET.COM

BOWLING GREEN MUNICIPAL UTILITIES

WASTEWATER TREATMENT PLANT EXPANSION AND RENOVATION

CONTRACT 3

BIOSOLIDS DRYER SYSTEM ADDITION

BOWLING GREEN MUNICIPAL UTILITIES
Warren County
Bowling Green, Kentucky
BGMU Project No. S07-653

REVISION		
No. -	Date -	Revision

REQUEST FOR PROPOSAL
BIOSOLIDS DRYER SYSTEM ADDITION

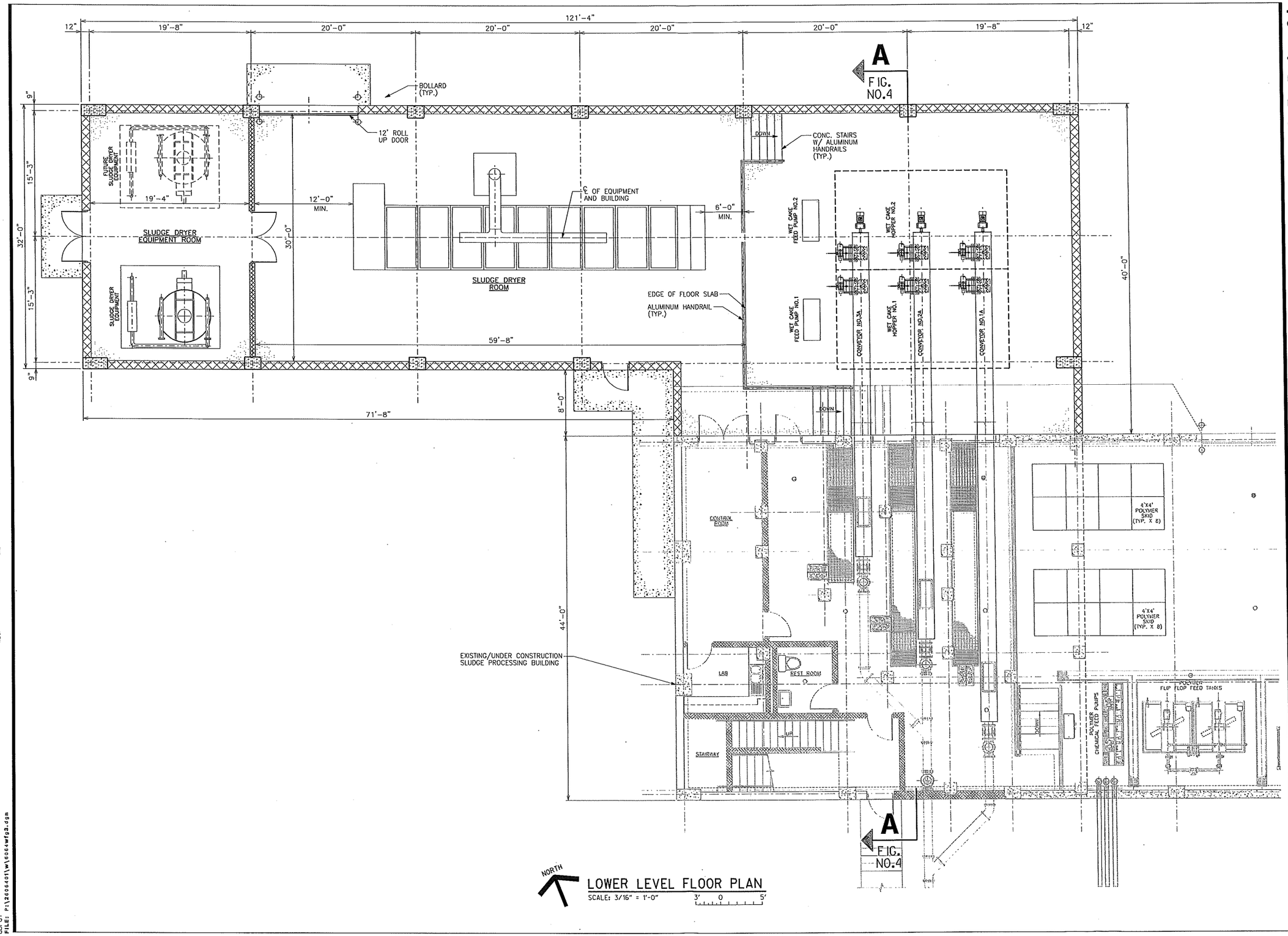
FIGURE NO:

2

PROJECT: 26064.01
DATE: OCTOBER 2009

FILE: P:\26064.01\W16064wfg2.dgn

B.O.



PRELIMINARY - For Review Only

G S & P

Design Services For The Built Environment

Atlanta
Birmingham
Charlotte
Cincinnati
Columbus
Dallas
Fort Lauderdale
Jacksonville
Louisville
Memphis
Nashville
Richmond
Tampa

GRESHAM SMITH AND PARTNERS

WWW.GSPNET.COM

BOWLING GREEN MUNICIPAL UTILITIES

WASTEWATER TREATMENT PLANT EXPANSION AND RENOVATION

CONTRACT 3

BIOSOLIDS DRYER SYSTEM ADDITION

BOWLING GREEN MUNICIPAL UTILITIES
Warren County
Bowling Green, Kentucky
BGMU Project No. S07-653

REVISION

No.	Date	Revision

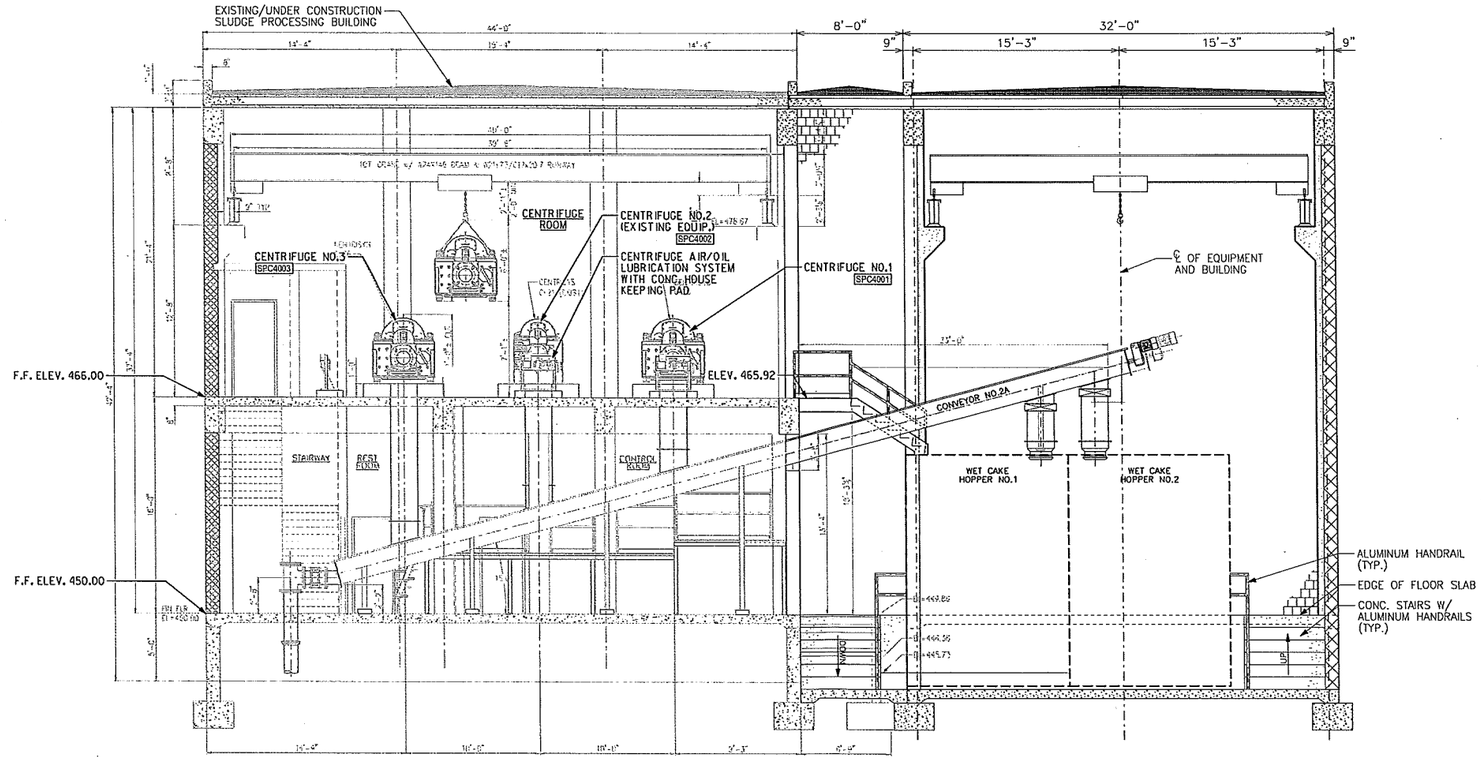
REQUEST FOR PROPOSAL
BIOSOLIDS DRYER SYSTEM ADDITION

FIGURE NO:

3

PROJECT: 26064.01
DATE: OCTOBER 2009

dbrot
FILE: P:\26064.01\w\606dwfig3.dgn
B.O.



A SECTION

SCALE: 3/16" = 1'-0"

3' 0 5'

PRELIMINARY - For Review Only

G S & P

Design Services
For The Built
Environment

Atlanta
Birmingham
Charlotte
Cincinnati
Columbus
Dallas
Fort Lauderdale
Jacksonville
Louisville
Memphis
Nashville
Richmond
Tampa

GRESHAM
SMITH AND
PARTNERS

WWW.GSPNET.COM

BOWLING GREEN MUNICIPAL UTILITIES

WASTEWATER TREATMENT PLANT EXPANSION AND RENOVATION

CONTRACT 3

BIOSOLIDS DRYER
SYSTEM ADDITION

BOWLING GREEN
MUNICIPAL UTILITIES

Warren County
Bowling Green, Kentucky

BGMU Project No. S07-653

REVISION		
No. –	Date –	Revision

REQUEST FOR PROPOSAL
BIOSOLIDS DRYER
SYSTEM ADDITION

FIGURE NO:

4

PROJECT: 26064.01
DATE: OCTOBER 2009

dbrot
FILE: P:\26064.01\wl\606swfg4.dgn

B.O.

AMENDMENT NO. 1
BGMU PROJECT NO. S07-653
GS&P PROJECT NO. 26064.00

Notice to: All Prospective Offerors

From: Mike Burgett, P.E.
Gresham, Smith and Partners

Re: Request for Proposals
Biosolids Dryer System

Date: November 12, 2009

Acknowledge receipt of this Amendment in the space provided on page 2 of the Proposal Form and include a copy of this document with your proposal submittal. Failure to do so may subject the prospective proposers to disqualification. This Amendment forms part of the above-mentioned procurement and clarifies the previously issued documents.

The following Amendment items supplement, modify, change, delete from, or add to the Request for Proposals issued October 29, 2009. Where any provision or requirement, or Article, Paragraph, Subparagraph, Section or Clause is modified or deleted by this amendment, the unaltered portion(s) of any provision or requirement, or Article, Paragraph, Subparagraph, Section or Clause shall remain in effect.

MODIFICATIONS

1.1 SCOPE OF SUPPLY

1. Revise the first bullet of the third paragraph to read:

   "For Phase I, the Dryer capacity shall be a minimum of 24 dry tons per operational day. The proposed dryer shall be capable of processing the solids given the input concentrations and operational times listed below. Operational hours include start up and shut down. The dryer system shall be expandable to 33.6 dry tons per operational day for Phase II;"

2. On page SS-1, revise paragraph 4 to read as follows:

   "The equipment provided in this proposal shall consist of one complete and operational solids dryer system and controls to process thickened biosolids dewatered by centrifuges. The biosolids dryer system shall be factory assembled and disassembled as necessary for transportation to the project site."

1.2 PROPOSAL INSTRUCTIONS

1. On page PI-3, revise the projected timetable as follows:

Request for Proposals Issued	October 29, 2009
Deadline for Equipment Pre-submittals	November 5, 2009
Deadline for Questions (3:00 pm Bowling Green Local Time)	November 9, 2009
Issue Amendment for Proposal Questions and for Listing Approved Manufacturers	November 12, 2009
Proposals Due (2:00 pm Bowling Green Local Time)	**November 25, 2009**
Evaluation of Proposals	**December 4, 2009**
Complete Contract Negotiations and Award Contract	ASAP

1. On page PI-4, under Item 3.c. insert the following after the first sentence:

   "For all information requested herein, differentiate between Phase I (24 dry tons per operational day) and Phase II (33.6 dry tons per operational day) requirements."

2. On page PI-5, under Item 3.c. add the following to the fourth bullet:

   "If the dryer system utilizes reuse water, the proposer shall include the required annual usage with no annual cost; however, proposer shall include associated capital costs for necessary equipment such as for automatic strainers, etc."

3. On page PI-5, under Item 3.c. add the following to the fifth bullet:

   "If no maintenance items and costs are provided, the costs will be assumed to be equal to 10% of capital costs."

4. On page PI-6, under 3.f, add the following paragraph:

   "Prior to issuance of a purchase order the Owner will require the selected proposer to secure and post a payment bond in the amount of 100% of the purchase order amount. Payment Bond form is attached to this Request for Proposals."

5. On page PI-6, revise the second sentence of Item 3.h. to read:

   "Information for the equipment, controls and materials described in this Request for Proposals must show, as a minimum, the following information for Phase 1 and Phase 2 criteria:"

6. On page PI-7, under Item 5, Proposal Review and Award, revise sentence four to read as follows:

   "Life cycle cost comparison information required to be submitted for evaluation includes items listed at Paragraph 3.c. of the Request for Proposals and the total base quote **and additive alternates** for equipment provided on the Proposal Form.

7. On page PI-13, under Item 11, Start Up Services and Operator Training, revise sentence six to read as follows:

   "This on-site time is dependent upon the complexity of the equipment and may vary between Proposers; however, it shall be a minimum of **90 man-days** on-site factory service during start-up and operation and maintenance training."

8. On page PI-13, under Item 13, Materials to be Provided by the Proposer, add the following to the end of the second paragraph:

   "A contractor representing the Owner will connect system components and provide motor control center. All internal system piping, wiring, valves and supports shall be furnished and installed by Proposer."

9. On page PI-14, under Item 15, Schedule and Liquidated Damages, add the following paragraph:

   "Failure to meet the requirements of the Request for Proposals at maximum utility usages supplied in proposal within 5 months of start-up will result in liquidated damages of $3,000.00 per calendar day until compliance is achieved. Failure to meet the requirements of the Request for Proposals at maximum utility usages supplied in proposal after 1 year of operation will result in the manufacturer refunding the Owner all costs for the Dryer System, payment of liquidated damages of $1,000,000, and removal of the dryer system at proposer's expense."

10. On page PI-15, under Item 18, Attachments, add the following:

    - "Payment Bond"

11. The Proposal Form shall be replaced with the attached Revised Proposal Form.

12. Figure No. 1 shall be replaced with the attached revised Figure No. 1.

1.3 SECTION 44 4618 – INDIRECT DRYER SYSTEM:

1. On page 3, replace paragraph 1.5.C. with the following:

   "Dryer manufacturer shall provide a certificate of conformance at time of shipment to confirm that the dryer supplied meets these specifications and design criteria."

2. On page 4, under paragraph 2.1.B. remove the second sentence.

3. On page 5, under paragraph 2.4.A.3. revise to read as follows:

   "a. Minimum Phase I Throughput: 24.0 dry tons per operational day

   b. Minimum Phase II Throughput: 33.6 dry tons per operational day"

4. On page 5, delete item 2.4.A.6. in its entirety.

5. On page 5, under paragraph 2.4.A.7., revise to read as follows:

   "7. **Operational** Run Time

a. Hours/Day: 24

b. Days/Week 5 "

6. On page 6, under paragraph 2.4.B.3. revise sentence one to read as follows:

   "Tests shall consist of a minimum of 3 tests. Each test shall be performed over a 24-hour minimum period."

7. On page 6, under 2.6.B. add the following sentence:

   "The dryer system controls shall allow for single button system start-up and single button system shut down."

8. On page 6, under paragraph 2.7.A. revise to read as follows:

   "A. Upon completion of the indirect dryer installation and at a time designated by the Owner, the services of one factory service engineer shall be provided for a period of not less than **ninety (90)** days to start-up equipment, complete performance testing, and train Owner's personnel in the operation and maintenance of the equipment furnished."

QUESTIONS / ANSWERS

1. **QUESTION**: Per the specification, page SS-1 and Section 44 4618 page 4 of 7, item B: Method of heating shall be indirect, meaning the heating medium is not in contact with the product being heated. No other systems will be considered. Please reconsider restating using information below:

   "Air heated by a furnace transferred to the dryer is considered indirect since no fire is in contact with the sludge and air is below 150°C. Belt dryers use heated air (convection) that does contact the sludge whereas indirect drying normally refers to a heated thermal liquid recycled through a hollow shaft whereas the heated metal surface contacts (conduction) the sludge."

   ANSWER: *Manufacturers approved to submit Proposals are listed in Item 8 of the Proposal Instructions.*

2. **QUESTION**: Section 44 4618-Page 5 of 7, Item 2.3 System Requirements, B. The wet cake discharged from the centrifuges will be conveyed to a wet cake hopper, the biosolids are pumped into the indirect dryer with a progressive cavity type pump. The progressive cavity pumps are sized for 35 GPM at 60 PSI discharge and will operate in duty standby position. Question: Who is responsible to supply wet cake bin, sludge pumps, cake piping? Drawings indicate 200 yds^3 storage, is that split between 2 tanks, 100 yds^3 per tank?

   ANSWER: *Wet cake hopper, piping, and pumps are not part of this RFP.*

3. **QUESTION**: Section 44 4618-Page 3 of 7, Part 2-Products, Item 2.1 General A. references discharging to silos. What is the boundary of supply for the belt dryer does it end at final product discharge point or does the system include silo. Drawing shows a screw conveyor but based on capacity of silo the unit would be approximately 80 ft

tall and 32 ft diameter. Most likely the solids would need to be pneumatically conveyed.

ANSWER: *Dry product storage is not part of this RFP.*

4. **QUESTION**: The building dimensions are fairly tight for a dryer to process 24 DTPD in width and length as well as height. Is this dimension fixed or preliminary as drawing stamped?

   ANSWER: *Vendor shall supply equipment footprint and proposed floor plan with proposal and note additional space requirement as an exception. Additional space requirements will be evaluated during proposal review.*

5. **QUESTION**: We are going to quote 316L as requested but also offer a deduction for Carbon Steel. Is this acceptable?

   ANSWER: *Yes*

6. **QUESTION**: Is the Energy Recovery System required? The proposal is weighted heavily towards 20 year Life cycle cost, it could be to our advantage to also propose an optional heat recovery system. We want to add an option for purchase of a gasification system with near zero emissions that has an installation in the US operating on municipal sludge. We are proposing to offer in our system as a optional future add on. Is this acceptable?

   ANSWER: *The energy recovery system is not required. Yes, listing it as an exception for BGMU to consider is acceptable.*

7. **QUESTION:** Regarding the bonding, we were asking, can we offer a commercial letter of credit rather than a bond?

   ANSWER: *In lieu of a Bid Bond a certified check from a reputable and solvent financial institution may be used.*

8. **QUESTION**: Typically we offset our 20 year life cycle cost estimates by deducting for selling the dried biosolids. In calculating the lifecycle cost of operation will this be included? If so how will the resale price be defined? If your concerned about metals content in the sludge it might be better to just leave this out.

   ANSWER: *Resale price for biosolids will be considered as part of this RFP. Prices will be defined by Owner and Engineer based upon recent market studies.*

9. **QUESTION**: On SS-1: Please clarify the scope of supply for the wet sludge and dried sludge transport and storage. Is the dryer supplier supposed to include storage silos/bins and conveyors for both wet and dry product storage?

   ANSWER: *See Questions 2 & 3 above.*

10. **QUESTION**: On page SS-1 and in Section 44 4618 1.6 B: "The equipment provided in this proposal shall consist of one complete and operational factory assembled solids dryer system and controls to process thickened biosolids dewatered by centrifuges."

For a dryer of this size, Kruger will supply a dryer that will be shipped in modules for onsite assembly by the installation contractor. The modules will be fit up in the factory before shipment. The spec section 44 4618 also states that items should be "shipped as complete assemblies except where partial disassembly is required by transportation regulations or for protection of components." All instruments will be shipped loose for installation and wiring onsite by the installation contractor.

ANSWER: *See item 1.1.2 above. Please note field installation requirements in proposal.*

11. **QUESTION**: On page SS-1: "An electrical subcontractor will connect the system components; however, control panel and equipment internal connections shall be made by the equipment manufacturer."

    Please clarify that is acceptable for the electrical contractor to supply field wiring, conduit, raceways, junction boxes or safety switches

    ANSWER: *See item 1.2.8 above.*

12. **QUESTION**: On page SS-2: "Proposal must have a factory-authorized service representative on site during the installation and start-up of the dryer system and during any prescribed on-site operation and maintenance training for the Biosolids Dryer System as defined in the Request for Proposals."

    A minimum time required for installation supervision is not defined. Kruger suggests a minimum on site time of 15 days and three (3) trips for installation supervision by specified.

    Minimum times for start-up and training are defined on page PI-13, item 11.

    ANSWER: *See item 1.2.7 above.*

13. **QUESTION**: Page PI-3, 3a & Figure number 3: Kruger's drying system for a plant of this size will not fit in the dryer room as shown on figure 3. Are larger footprints acceptable for a drying system? If so, is there a penalty associated with this in the evaluation?

    ANSWER: *See Question 4 above.*

14. **QUESTION**: On page PI-3, 3b & Section 44 4618 1.3 G & 2.1 D: Greenhouse Gas guarantee. If this only pertains to the burner, Kruger can supply a guarantee based upon the natural gas composition. Please forward the natural gas composition for the site. If this applies to the system as a whole, we will also need an elemental sludge analysis from the plant to ensure the correct emissions.

    ANSWER: *Greenhouse Gas guarantee applies to complete dryer system. See attached sludge analyses which are provided for preliminary review purposes only. Given the limited data available, the Proposer shall utilize typical data based upon experience to design the system components.*

15. **QUESTION**: On page PI-5, 3d: Section 3d in Proposal Instructions asks for the dryer manufacturer to define classification area requirements. This is typically the scope for the consulting engineer or local code enforcement official. Per NFPA 654 Kruger

does not foresee the need for any hazardous location for our equipment. Please confirm this is acceptable with the owners.

ANSWER: *Classification requirements provided in proposals are to be in accordance with NFPA 654 and 820.*

16. **QUESTION**: On Page PI-5, 3.h.7. Please define the operational range diagrams?

    ANSWER: *Proposer shall provide diagrams depicting operational ranges for each piece of equipment supplied such as throughput versus % solids output.*

17. **QUESTION**: On Page PI-13, 13: "The equipment described in this Request for Proposals shall be unloaded, stored and installed by a Contractor representing the Owner. The contractor will only supply labor for installation, assistance with start-up and any grouting work required for installation."

    This statement appears to indicate the proposals are to be for "turn-key" type system where the equipment supplier is to provide, interconnecting piping, ductwork, wiring and conduit along with platforms and anchor bolts. The storage statement also conflicts some with requirement 7 for equipment storage.

    General Questions:

    Is interconnecting piping and ductwork to be included in our scope? If yes, does this also pertain to the sludge piping?

    Please define SCADA and MCCs scope of supply?

    ANSWER: *See Modifications above. Internal piping and ductwork is responsibility of equipment supplier. Any piping and ductwork external of the dryer will be by the Contractor.*

18. **QUESTION**: On page PI-14, 14: "In general, electrical equipment described in this Request for Proposals will be connected to the electrical system furnished and installed by an Electrical Subcontractor representing the owner. THE VENDOR SHALL BE RESPONSIBLE FOR ANY CHANGES IN ELECTRICAL EQUIPMENT CAUSED BY AN INCREASE IN HORSEPOWER. ANY CHANGES CAUSED BY SUCH AN INCREASE IN HORSEPOWER SHALL BE AT NO EXPENSE TO THE CONTRACTOR OR THE OWNER."

    This statement ties Kruger into the motor list defined in the proposal with any changes potentially causing back charges. Although the list should be mostly correct, with such a short turn around time (two weeks) it is likely that some of the motor sizes may not be fully iterated based on the effect of all of the finalized system components. This will be especially true if dried product storage and handling is included in Kruger's proposal or if the wet sludge storage system as shown in the drawings is included in the proposal.

    ANSWER: *Note clarifications above on equipment to be supplied. List any exceptions taken to the RFP. All exceptions will be evaluated.*

19. **QUESTION**: In Section 44 4618 2.1 B: "Method of heating shall be indirect, meaning the heating medium is not in contact with the product being heated. No other systems will be considered."

Kruger's dryer is a convection belt dryer that is indirect as defined by NFPA standards. Kruger will heat thermal oil and/or hot water by a natural gas fired burner and the heat will be transferred to the drying air via heat exchangers mounted on the drying cabinet. The product being dried is isolated from the products of combustion. Please clarify that this is acceptable to the definition stated in the specifications.

ANSWER: *See Question 1 above.*

20. **QUESTION**: In Section 44 4618 2.3 A.6.: With Kruger's closed loop system, a separate odor control system is not typically required. The small amount of air extracted to maintain a vacuum on the system is sent through a packed bed scrubber and mixed with ambient air to be used as combustion air for the process burners. This method of operation eliminates the need for a separate odor control system so it will not be included in the scope of supply. Please confirm this is acceptable.

    ANSWER: *List any exceptions taken to the RFP. All exceptions will be evaluated.*

21. **QUESTION**: In Section 44 4618 2.4 A.10: The Kruger Belt dryer produces granulated particles suitable for industrial and commercial use. Kruger has not included provisions for processing the Biosolids to 1-4mm size with the current pricing. This product has been witnessed by the end user and engineer. Please confirm our end product is acceptable.

    ANSWER: *List any exceptions taken to the RFP including particle size gradation variations. All exceptions will be evaluated.*

22. **QUESTION**: In Section 44 4618 2.4 A.10: Please provide the elemental sludge content so we can estimate the H_2S removal efficiency.

    ANSWER: *See attached sludge analyses which are provided for preliminary review purposes only. Given the limited data available, the Proposer shall utilize typical data based upon experience to design the system components.*

23. **QUESTION**: In Section 44 4618 2.6 E: "The dryer should provide controls for operation of the wet cake hopper, with live bottom, and wet cake pumps."

    This seems to indicate that the dryer manufacturer will not supply the actual equipment, just control it. Is this correct?

    ANSWER: *See Questions 2 & 3 above.*

24. **QUESTION**: In the Package Control Systems Section 40 9990, 2.3.D.: "All panels shall be NEMA 250, Type 4X Panels: Type 316 stainless steel construction unless otherwise specified."

    Where will the Dryer PLC Control Panel be located and what NEMA rating will be required?

    If the Dryer PLC Control Panel is located in an Electrical Room, the Panel could be NEMA 12.

    ANSWER: *Dryer PLC Control Panel is to be located in the Dryer Building. NEMA 4X is required.*

25. **QUESTION**: In the Package Control Systems Section 40 9990, 2.4.G.5.: "5. Terminal Block, Blade Disconnect Switch: a. Use: Provide one for each discrete input and output field interface wire. b. Rated Voltage: 600V ac. c. Rated Current: 10 amps. d. Wire Size: 22 through 12 AWG. e. Rated Wire Size: 12 AWG. f. Color: Gray body, orange switch. g. Spacing: 0.25 inch, maximum."

    Do all Digital Inputs have to use Terminal Block Blade Disconnect Switch? Kruger normally connects all PLC Digital Outputs to an Interposing Relay, would this be acceptable or do Digital Outputs require Terminal Block Blade Disconnect Switch? Kruger normally uses Phoenix Contact terminal blocks, would Phoenix Contact be an acceptable equal?

    ANSWER: *List any exceptions taken to the RFP. All exceptions will be evaluated.*

26. **QUESTION**: In the Package Control Systems Section 40 9990, 2.4.K.6.c.: "c. Analog Input/Output Modules: 1) Voltage: 24 volts dc. 2) Power: 3 watts. 3) Differential Analog Points Per Module: 8 maximum. 4) Isolated Analog Output Points Per Module: 8 maximum. 5) Isolation: Between"

    For Control Logix Analog Input modules, Allen Bradley manufactures a 16 Pt Analog Input Module, 1756-IF16, would this unit be acceptable, it would conserve PLC Chassis and Panel space.

    ANSWER: *List any exceptions taken to the RFP. All exceptions will be evaluated.*

27. **QUESTION**: In the Package Control Systems Section 40 9990: 2.10.D.: "D. Power Supply Suppressor Assemblies: 1. Suitable for connection to 120-volt, single-phase power supplies under15 amps EDCO "HSP SERIES" or approved equal. 2. Suitable for connection to 120-volt, single-phase power supplies over15 amps EDCO "IL SERIES" or approved equal. 3. Suitable for connection to 480-volt, three-phase power supplies; Square D J9200-9A or EDCO "IL SERIES" or approved equal."

    Kruger normally supplies the Phoenix Contact SFP 1-20/120AC for 120VAC Surge Protection for the incoming power to the Control Panel, would this be an acceptable equal?

    ANSWER: *List any exceptions taken to the RFP. All exceptions will be evaluated.*

28. **QUESTION**: In the Package Control Systems Section 40 9990, 2.10.F.: "F. Physical Characteristics: 1. Mounted in Enclosures: Encapsulated inflame retardant epoxy. 2. For all Analog Signals Lines: EDCO PC-642 or SRA-64 series or approved equal. 3. Field Mounted at Two-Wire Instruments: Encapsulated in stainless steel pipe nipples. EDCO SS64 series or approved equal. 4. Four-Wire Instruments: With 120V ac outlet, ac circuit breaker, including surge suppressor for signal as well as 120V power line, all in enclosure. EDCO SLAC series or approved equal."

    For Analog Signal within the Control Panel Kruger normally supplies the Phoenix Contact PT2x2 24DC ST to protect the 4-20mA signal, would this be an acceptable equal?

For Field Mounted Two-Wire Instruments, Kruger normally uses the Phoenix Contact Pipetrab S-PT1-2PE-24DC for protection of the 4-20mA signal, would this be an acceptable equal?

For Field Mounted Four-Wire Instruments, Kruger normally uses the Phoenix Contact Boxtrab BXT-N4X 4-Wire to protect the 120VAC Power Feed and the 4-20mA, would this be an acceptable equal?

Do the 120VAC Field Instruments have to be powered form the Dryer Panel or are they powered from another source?

ANSWER: *List any exceptions taken to the RFP. All exceptions will be evaluated.*

29. **QUESTION**: In the Indirect Dryer System Section 44 4618, 2.6: "2.6 CONTROL SYSTEM

A. Control Enclosures shall be stainless steel, NEMA 4X, UL labeled.

B. Control System shall comply with Division 40, Section "Packaged Control Systems"."

Where will the Dryer PLC Control Panel be located and what NEMA rating will be required?

If the Dryer PLC Control Panel is located in an Electrical Room, the Panel could be NEMA 12.

ANSWER: *See Question 24 above.*

30. **QUESTION**: In the Indirect Dryer System Section 44 4618, 2.6.D.: "D. SCADA: The SCADA system shall provide feedback information on system components, alarms, historical trending, and allow the operator to modify set points. SCADA system shall communicate via Ethernet."

Is the Dyer System Supplier responsible for supplying the SCADA System?

Will the SCADA System monitor the entire plant or will it be broken down into area nodes that monitor that system or area only?

Please clarify what SCADA System software is required as well as hardware.

ANSWER: *The Dryer System supplier is responsible for providing feedback information on system components via Ethernet to a plant SCADA system supplied by others which is broken down into area nodes. Please refer to Specification Section 40 9990, Package Control System.*

31. **QUESTION**: We are preparing the paperwork for the Bond now, will there be any bonds required after the bid is awarded?

ANSWER: *Yes, see item 1.2.4 above.*

32. **QUESTION**: We cannot accept the payment terms as requested in the bid spec. Is BGMU willing to accept our terms per our pre-spec proposal or are they willing to negotiate something in the middle if our equipment is selected?

ANSWER: *List any exceptions taken to the RFP. All exceptions will be evaluated.*

33. **QUESTION**: "The Proposer shall provide a Biosolids Dryer System with all related appurtenances for a complete and operable system." Page SS-1

Based on the Bowling Green Municipal Utilities (BGMU) Request for Quotation, the Indirect Dryer System scope of supply does not include the wet cake storage hoppers, dryer feed pumps and dry product handling transportation and storage. In the RFQ Section 44 4618 Part 2.3, these specific processes are not listed on the minimum requirements for the Indirect System Supplier.

Komline-Sanderson suggests that the wet cake hopper, wet cake feed pumps and dried product handling, including dried product storage be included within the minimum scope of supply for the Dryer System...

ANSWER: *See Questions 2 & 3 above.*

34. **QUESTION**: "The equipment provided in this proposal shall consist of one complete and operational factory assembled solids dryer system and controls to process thickened biosolids dewatered by centrifuges." Page SS-1

Komline-Sanderson requests that "factory assembled system" be removed from this sentence. It is not possible that this system can be assembled at the factory due to its size and complexity. The Komline-Sanderson Paddle Dryer itself will be fully assembled in our facility. Due to the size of the proposed unit, the dryer must be delivered partially disassembled because of shipping limitations. The dryer will then be reassembled in the field. This will normally consist of joining sections by mechanical means such as with bolts, nuts and screws.

ANSWER: *See item 1.1.2 above.*

35. **QUESTION**: "Input (feed) solids concentrations are estimated to vary between 15% to 18%." Page SS-1

Komline-Sanderson recommends that the guaranteed performance rate be based on an operating condition processing incoming solids of 15%, the highest evaporation rate that you specified. This is an evaporation rate of 11,159 #/hr. water evaporated.

It is our recommendation that a much broader incoming feed solids concentration of 14-22% be specified for the range that the equipment must operate. If the feed solids are higher than anticipated, you do not want to limit the operation of the drying system.

Using a broader incoming solids concentration range anticipates that, not only the dryer, but all the auxiliary equipment will be able to handle fluctuations both daily and for the anticipated 20 year equipment life cycle. A narrow incoming feed solids concentration also allows the equipment supplier to void any process guarantees if the incoming feed solids are outside the specified range.

ANSWER: *Design criteria shall be as noted in RFP and specifications.*

36. **QUESTION**: Section 3 C. Life Cycle Page PI-4

For process guarantees, Komline-Sanderson recommends that that the biosolids drying system have specific guarantees...

ANSWER: *See item 1.2.9 above.*

37. **QUESTION**: Section PI-3C. Life Cycle "The Owner's water usage cost is estimated at $2.40 per one thousand gallons." Page PI-5

    Is this the water usage cost for potable water? Is this also the cost for non-potable water?

    ANSWER: *See item 1.2.2 above.*

38. **QUESTION**: Section PI-3D. "Classification requirements for all equipment. Proposals shall include costs for equipment and controls appropriate for the area classification. Additionally, classification requirements supplied by the Proposers shall be utilized during the evaluations to assess extra costs associated with added construction requirements due to equipment/area classifications." Page PI-5

    Komline-Sanderson is recommending classification requirements to be based on the NFPA 820 code.

    ANSWER: *Classification requirements provided in proposals are to be in accordance with NFPA 654 and 820.*

39. **QUESTION**: Section PI-7 Equipment Delivery Schedule Page PI-9: "The estimated delivery date for the equipment October 2010."

    Komline-Sanderson is requesting that the equipment delivery schedule be adjusted to 13 Months from the time of order to the time of delivery.

    ANSWER: *If manufacturer is unable to deliver equipment within proposed timeframe, it should be listed as an exception to the RFP. All exceptions will be evaluated.*

40. **QUESTION**: Section PI-11 Start Up Services and Operator Training: "This on-site time for start-up services and may vary between Proposers; however, it shall be a minimum of two man-days on-site service for operation and maintenance training." Page PI-13.

    Based on previous experience with similar proposed Biosolids Drying Systems Komline-Sanderson recommends the Proposer supply between 90-180 on-site man days, which will be included into the Proposal Bid Price...

    ANSWER: *See item 1.2.7. above.*

41. **QUESTION**: Section PI-13 Materials to be Provided by the Proposer: "The equipment described in this Request for Proposals shall be unloaded, storage and installed by a Contractor representing the Owner. The Contractor will supply labor for installation, assistance with start-up and any grout work required for installation." Page PI-13

    We assume that the contractor will supply piping, wiring, motor control center, manual valves, foundations, supports, as required for the installation. We suggest that the wording be modified to indicate the contractor's responsibility.

    ANSWER: *See 1.2.8 above.*

42. **QUESTION**: Section PI-15 Schedule and Liquidated Damages: "The Proposer shall submit with his proposal a guaranteed time schedule for delivery of submittals after issuance of the Purchase Order and the equipment specified herein shall be delivered to the project site by the date specified in Item 7 above. If completion of the project is delayed due to failure to meet this delivery date, the Owner will suffer damages difficult to ascertain at this point, but agreed by both parties to be at least $500.00 per calendar day. Liquidated damages will be assessed to the Vendor in that amount for each calendar day after equipment delivery date that the equipment is not delivered." Page PI-14

    The delivery of engineering drawing submittals is a series of submittals starting with layout drawings, P&IDs and process flow diagrams. Electrical drawings are always the final drawings to be submitted since engineering approval must be completed of the P&IDs. Komline-Sanderson suggests that liquidated damages for drawing submittals be omitted since there is no specific event that allows you to assess damages. Liquidated damages for late equipment delivery would be acceptable.

    ANSWER: *Liquidated damages will only be assessed for late equipment delivery.*

43. **QUESTION**: Section 444618 1.2B Page 1 "All equipment included in this section shall be furnished by a single supplier who shall be responsible for the design, coordination, and satisfactory operation of the system."

    As mentioned previously, Komline-Sanderson suggests that a single supplier furnish the wet cake feed system, the drying system and the dry product transportation and storage system. It is also the responsibility of the supplier to integrate all of these systems into one functional installation. Below is a breakdown of the expected responsibilities for the Contractor and the System Supplier…

    ANSWER: *The Engineer will consult with selected proposer during detailed design of the remaining components of solids drying system.*

44. **QUESTION**: Section 444618 1.4D Page 2 "All materials submitted for review shall be contained in one submission. Partial submittals will not be reviewed. Sales bulletins or other general publications are not acceptable for review, except where necessary to provide supplemental technical data."

    Komline-Sanderson requests that the materials submittal be changed to remove the phrase "one submission"…

    ANSWER: *List any exceptions taken to the RFP. All exceptions will be evaluated.*

45. **QUESTION**: Section 44 4618, 1.4 E., Page 2, Performance Affidavit: Komline-Sanderson suggest that BGMU require a performance and payment bond in addition to the specified Bid Bond...

    ANSWER: *See item 1.2.4 above.*

46. **QUESTION**: Section 444618, Part 2.1B Page 4 "Method of heating shall be indirect, meaning the heating medium is not in contact with the product being heated. No other systems will be considered."

We note on your approved vendor list that two of the suppliers would be offering belt dryers, which are direct dryers by definition. We assume that your statement that indirect dryers are the only technology accepted is not correct. We suggest that you change your bid document to indicate that both direct and indirect dryers are acceptable. We believe that you wish to eliminate the use of drum dryers rather than the use of belt dryers.

ANSWER: *Manufacturers approved to submit Proposals are listed in Item 8 of the Proposal Instructions.*

47. **QUESTION**: Section 444618, Part 2.3B Page 5 "The progressive cavity pumps are sized for 35 gpm at 60 psi and will operate in a duty/standby configuration."

    It has been our experience with progressing cavity pumps that the operating pressure is a function of the pipe size, distance, geometry and the viscosity of the sludge when determining the pressure drop the pump must overcome. As a general rule of thumb we recommend that the discharge pump pressure be approximately 2 psi per linear foot of pipe. Therefore we recommend that the stated pressure be removed as it will be too low for proper operation.

    ANSWER: *Progressive cavity pumps are not part of this RFP. Design point will be refined once dryer has been selected.*

48. **QUESTION**: Section 444618, Part 2.4A10 Page 5:

    "Odor Control

    a. Peak H2S Loading (ppm): 50

    b. Removal Efficiency (%): 99"

    As stated in both our Budget Proposal and our Dryer System Specification, off-gas produced from our dryer system will be discharged to the SBR's upstream through a course bubble diffuser.

    Since we are using the SBR as the bio scrubber and the SBR is not covered, the removal efficiency of H_2S cannot be measured. We have data that indicates that the H_2S removal through the wet ring pump is approximately 60% and we feel that the additional 39% is achievable in the active SBR.

    We have performed this same operation in previous installations and have experienced no off-gas odor issues. Because of this, we believe that we will be within the above specified range, however this cannot be measured.

    ANSWER: *Utilization of the SBR as a bio scrubber will not be allowed. List any exceptions taken to the RFP. All exceptions will be evaluated.*

49. **QUESTION**: Section 44 4618, Part 2.4.A.11., Page 5: Final Product Particle Size 1-4 mm +/- 5%

    Komline-Sanderson believes that this size range is too narrow in scope. Although a relatively uniform size range has a certain aesthetic quality, our experience has been that handlers of dried biosolids, particularly for land application see no handling issues

with larger solids. We request that the particle size be 1 to 10 mm. The Komline-Sanderson dryer will have 90% in the 1 to 5 mm range.

ANSWER: *List any exceptions taken to the RFP including particle size gradation variations. All exceptions will be evaluated.*

50. **QUESTION**: Section 44 4618, Part 2.4.B.3., Page 6 "Test shall consist of a minimum of three (3) tests and shall be performed over a minimum of eight (8) hours."

    Due to the large throughput and size of the dryer, an eight hour test will be an insufficient amount of time to demonstrate compliance with the BGMU operating criteria. To verify compliance with the BGMU operating criteria, the dryer system would need to be operating at steady state conditions.

    To guarantee the dryer performance along with the auxiliary equipment over prolonged steady state conditions, Komline-Sanderson recommends that the test shall be conducted for three (3) tests over a minimum of 24 hours.

    ANSWER: *See item 1.3.6 above.*

51. **QUESTION**: Section 44 4618, Part 2.5.A., Page 6 "Indirect dryer to utilize 316 stainless steel components to prevent corrosion."

    Komline-Sanderson would like further clarification for the materials of construction for the proposed dryer system...

    ANSWER: *Dryer shall utilize 316 stainless steel on components where available. Equipment materials shall be evaluated during proposal review.*

52. **QUESTION**: Section 44 4618, Part 2.5.B., Page 6 "Flanges, other than structural connections, shall be ANSI BI6, Class 150 Type, raised face, slip-on weld."

    Komline-Sanderson would recommend that all oil and sludge feed piping lines be classified as 300 Pound Type flanges.

    We also recommend that the ducts from the dryer be changed to a fabricated flange, not an ANSI BI6 type.

    ANSWER: *List any exceptions taken to the RFP. All exceptions will be evaluated.*

PAYMENT BOND

Any singular reference to Contractor, Surety, Owner, or other party shall be considered plural where applicable.

CONTRACTOR (Name and Address):

SURETY (Name and Address of Principal Place of Business):

OWNER (Name and Address):

Bowling Green Municipal Utilities
801 Center Street
Bowling Green, Kentucky 42102

CONTRACT
Date:
Amount:
Description (Name and Location):

BOND
Bond Number:
Date (Not earlier than Contract Date):
Amount:
Modifications to this Bond Form:

Surety and Contractor, intending to be legally bound hereby, subject to the terms printed on the reverse side hereof, do each cause this Payment Bond to be duly executed on its behalf by its authorized officer, agent, or representative.

CONTRACTOR AS PRINCIPAL
Company:

Signature: _____ (Seal)
Name and Title:

SURETY

_____ (Seal)
Surety's Name and Corporate Seal

By: _____
Signature and Title
(Attach Power of Attorney)

(Space is provided below for signatures of additional parties, if required.)

Attest: _____
Signature and Title

CONTRACTOR AS PRINCIPAL
Company:

Signature: _____ (Seal)
Name and Title:

SURETY

_____ (Seal)
Surety's Name and Corporate Seal

By: _____
Signature and Title
(Attach Power of Attorney)

Attest: _____
Signature and Title:

EJCDC No. C-615 (2002 Edition)
Originally prepared through the joint efforts of the Surety Association of America, Engineers Joint Contract Documents Committee, the Associated General Contractors of America, the American Institute of Architects, the American Subcontractors Association, and the Associated Specialty Contractors.

1. Contractor and Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors, and assigns to Owner to pay for labor, materials, and equipment furnished by Claimants for use in the performance of the Contract, which is incorporated herein by reference.

2. With respect to Owner, this obligation shall be null and void if Contractor:

2.1. Promptly makes payment, directly or indirectly, for all sums due Claimants, and

2.2. Defends, indemnifies, and holds harmless Owner from all claims, demands, liens, or suits alleging non-payment by Contractor by any person or entity who furnished labor, materials, or equipment for use in the performance of the Contract, provided Owner has promptly notified Contractor and Surety (at the addresses described in Paragraph 12) of any claims, demands, liens, or suits and tendered defense of such claims, demands, liens, or suits to Contractor and Surety, and provided there is no Owner Default.

3. With respect to Claimants, this obligation shall be null and void if Contractor promptly makes payment, directly or indirectly, for all sums due.

4. Surety shall have no obligation to Claimants under this Bond until:

4.1. Claimants who are employed by or have a direct contract with Contractor have given notice to Surety (at the addresses described in Paragraph 12) and sent a copy, or notice thereof, to Owner, stating that a claim is being made under this Bond and, with substantial accuracy, the amount of the claim.

4.2. Claimants who do not have a direct contract with Contractor:

1. Have furnished written notice to Contractor and sent a copy, or notice thereof, to Owner, within 90 days after having last performed labor or last furnished materials or equipment included in the claim stating, with substantial accuracy, the amount of the claim and the name of the party to whom the materials or equipment were furnished or supplied, or for whom the labor was done or performed; and

2. Have either received a rejection in whole or in part from Contractor, or not received within 30 days of furnishing the above notice any communication from Contractor by which Contractor had indicated the claim will be paid directly or indirectly; and

3. Not having been paid within the above 30 days, have sent a written notice to Surety and sent a copy, or notice thereof, to Owner, stating that a claim is being made under this Bond and enclosing a copy of the previous written notice furnished to Contractor.

5. If a notice by a Claimant required by Paragraph 4 is provided by Owner to Contractor or to Surety, that is sufficient compliance.

6. When a Claimant has satisfied the conditions of Paragraph 4, the Surety shall promptly and at Surety's expense take the following actions:

6.1. Send an answer to that Claimant, with a copy to Owner, within 45 days after receipt of the claim, stating the amounts that are undisputed and the basis for challenging any amounts that are disputed.

6.2. Pay or arrange for payment of any undisputed amounts.

7. Surety's total obligation shall not exceed the amount of this Bond, and the amount of this Bond shall be credited for any payments made in good faith by Surety.

8. Amounts owed by Owner to Contractor under the Contract shall be used for the performance of the Contract and to satisfy claims, if any, under any performance bond. By Contractor furnishing and Owner accepting this Bond, they agree that all funds earned by Contractor in the performance of the Contract are dedicated to satisfy obligations of Contractor and Surety under this Bond, subject to Owner's priority to use the funds for the completion of the Work.

9. Surety shall not be liable to Owner, Claimants, or others for obligations of Contractor that are unrelated to the Contract. Owner shall not be liable for payment of any costs or expenses of any Claimant under this Bond, and shall have under this Bond no obligations to make payments to, give notices on behalf of, or otherwise have obligations to Claimants under this Bond.

10. Surety hereby waives notice of any change, including changes of time, to the Contract or to related Subcontracts, purchase orders and other obligations.

11. No suit or action shall be commenced by a Claimant under this Bond other than in a court of competent jurisdiction in the location in which the Work or part of the Work is located or after the expiration of one year from the date (1) on which the Claimant gave the notice required by Paragraph 4.1 or Paragraph 4.2.3, or (2) on which the last labor or service was performed by anyone or the last materials or equipment were furnished by anyone under the Construction Contract, whichever of (1) or (2) first occurs. If the provisions of this paragraph are void or prohibited by law, the minimum period of limitation available to sureties as a defense in the jurisdiction of the suit shall be applicable.

12. Notice to Surety, Owner, or Contractor shall be mailed or delivered to the addresses shown on the signature page. Actual receipt of notice by Surety, Owner, or Contractor, however accomplished, shall be sufficient compliance as of the date received at the address shown on the signature page.

13. When this Bond has been furnished to comply with a statutory requirement in the location where the Contract was to be performed, any provision in this Bond conflicting with said statutory requirement shall be deemed deleted herefrom and provisions conforming to such statutory requirement shall be deemed incorporated herein. The intent is that this Bond shall be construed as a statutory Bond and not as a common law bond.

14. Upon request of any person or entity appearing to be a potential beneficiary of this Bond, Contractor shall promptly furnish a copy of this Bond or shall permit a copy to be made.

15. DEFINITIONS

15.1. Claimant: An individual or entity having a direct contract with Contractor, or with a first-tier subcontractor of Contractor, to furnish labor, materials, or equipment for use in the performance of the Contract. The intent of this Bond shall be to include without limitation in the terms "labor, materials or equipment" that part of water, gas, power, light, heat, oil, gasoline, telephone service, or rental equipment used in the Contract, architectural and engineering services required for performance of the Work of Contractor and Contractor's Subcontractors, and all other items for which a mechanic's lien may be asserted in the jurisdiction where the labor, materials, or equipment were furnished.

15.2. Contract: The agreement between Owner and Contractor identified on the signature page, including all Contract Documents and changes thereto.

15.3. Owner Default: Failure of Owner, which has neither been remedied nor waived, to pay Contractor as required by the Contract or to perform and complete or comply with the other terms thereof.

FOR INFORMATION ONLY – Name, Address and Telephone
Surety Agency or Broker:
Owner's Representative (engineer or other party):



REVISED PROPOSAL FORM

Qty.	Description	Unit Price	Total Price
Base Quotation:			
1	Phase I Biosolids Dryer System (24 dry ton per operational day capacity)	$	$
	Total Base Quote		$
Additive Alternate:			
1	Biosolids Dryer System Upgrade to Phase II (33.6 dry ton per operational day capacity)	$	$
1	Monthly Fee for Storage of Equipment at Proposer's Facility Past Required Delivery Date (Storage Includes Providing Insurance of Equipment While on Proposer's Property and Providing Certificate of Insurance to Owner)	$	$

Bowling Green Municipal Utilities reserves the right to accept or reject any or all of the above listed items.

Company: _____

Authorized Representative: _____
Print Name, Title

_____
Signature

Office Telephone Number: (____) _____

Office Fax Number: (____) _____

Mobile Telephone Number: (____) _____

Address: _____

_____

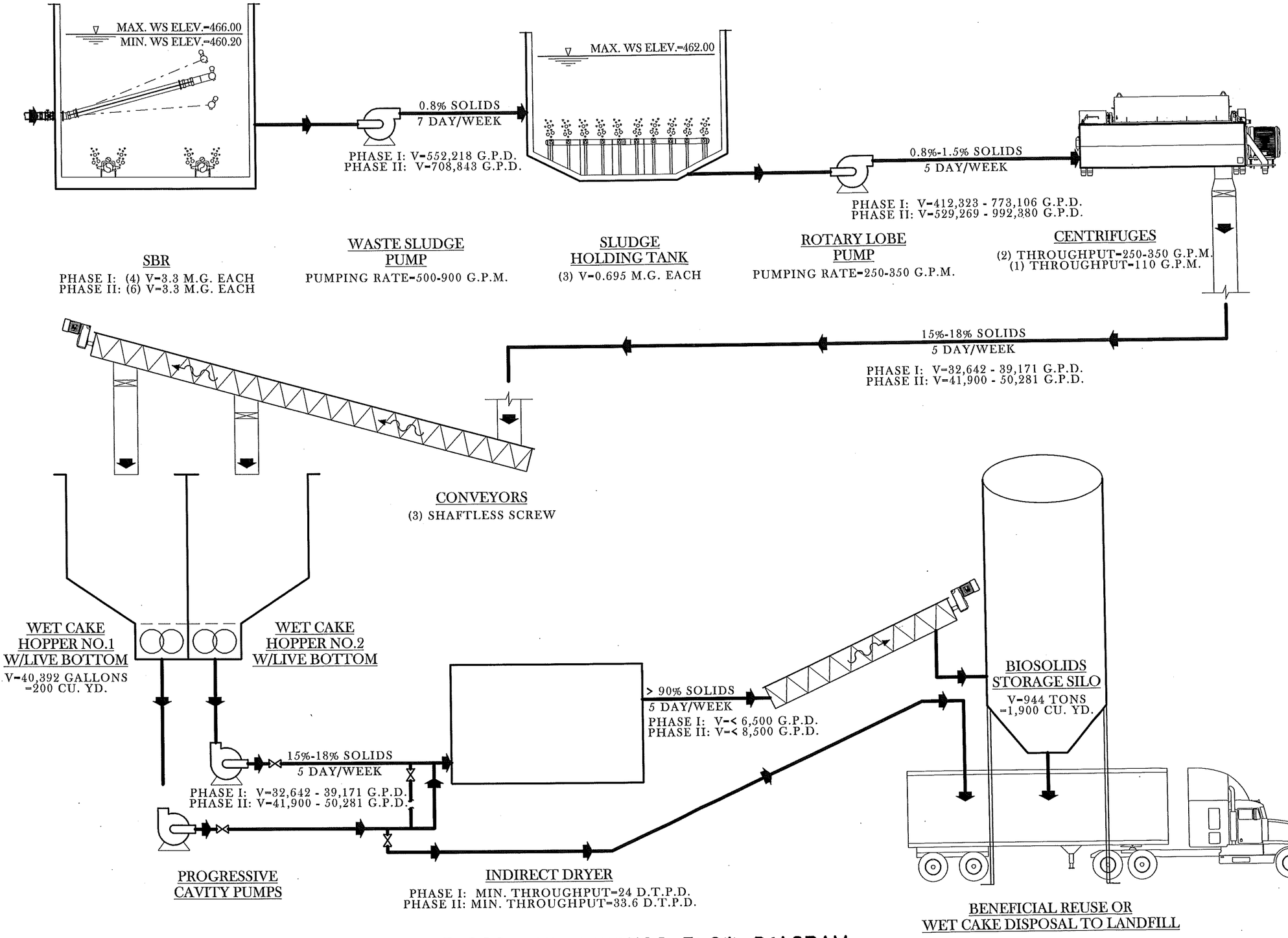
_____

E-mail Address: _____

Proposer has examined and carefully studied the Proposal Documents and the following Amendments, receipt of all which is hereby acknowledged (list each Amendment Number and Date):

Amendment Number	Amendment Date

Company Authorized Representative Initial here: _____



BIOSOLIDS PROCESS FLOW DIAGRAM

SCALE: N.T.S.

PRELIMINARY - For Review Only

G S & P

Design Services For The Built Environment

Atlanta
Birmingham
Charlotte
Cincinnati
Columbus
Dallas
Fort Lauderdale
Jacksonville
Louisville
Memphis
Nashville
Richmond
Tampa

GRESHAM SMITH AND PARTNERS

WWW.GSPNET.COM

WASTEWATER TREATMENT PLANT EXPANSION AND RENOVATION

CONTRACT 3

BIOSOLIDS DRYER SYSTEM ADDITION

BOWLING GREEN MUNICIPAL UTILITIES

Warren County
Bowling Green, Kentucky

BGMU Project No. S07-053

REVISION

No. -	Date -	Revision

REQUEST FOR PROPOSAL
BIOSOLIDS DRYER SYSTEM ADDITION

FIGURE NO:

1

PROJECT: 26064.01
DATE: OCTOBER 2009

B.O.

hdlk
FILE: P:\26064011\1064wfg1.dgn

2005 BELT PRESS CAKE ANALYSIS

	JAN (mg/kg) 1/6/2005	FEB (mg/kg) 2/8/2005	MAR (mg/kg) 3/8/2005	APR (mg/kg) 4/19/2005	MAY (mg/kg) 5/12/2005	JUN (mg/kg) 6/14/2005	JUL (mg/kg) 7/14/2005	AUG (mg/kg) 8/16/2005	SEP (mg/kg) 9/13/2005	OCT (mg/kg) 10/5/2005	NOV (mg/kg) 11/2/2005	DEC (mg/kg) 12/8/2005	AVG
pH	5.64	6.25	6.33	5.93	7.01	5.32	5.49	6.13	5.63	5.65	5.85	5.96	5.93
Percent Sol	28.2	19.1	27.1	27.3	30.6	27.1	14.4	21.7	29.7	30.4	26.4	27.5	25.8
Ammonia Nit	1035	3979	6930	9538	27778	7030	4153	9180	2240	5580	10100	580	7344
Total Nitro	12078	7869	34300	61663	77124	38900	51285	38313	7351	23400	25400	8356	32170
Nitrates	1.8	2.6	0.5	1.8	5.3	1.8	<3.5	<.5	<.5	1.64	70	<.5	10.7
Phosphorus	9800	1500	16000	20000	12000	15000	23000	20000	14000	2500	20000	13000	13900
PCB's	<0.18	<.26	<.18	<.19	<0.065	<.18	<0.36	<.23	<.17	<.16	<.19	<.18	#DIV/0!

METALS	JAN Dry Wt (mg/kg)	FEB Dry Wt (mg/kg)	MAR Dry Wt (mg/kg)	APR Dry Wt (mg/kg)	MAY Dry Wt (mg/kg)	JUN Dry Wt (mg/kg)	JUL Dry Wt (mg/kg)	AUG Dry Wt (mg/kg)	SEP Dry Wt (mg/kg)	OCT Dry Wt (mg/kg)	NOV Dry Wt (mg/kg)	DEC Dry Wt (mg/kg)	Conc. Limits	AVG
Arsenic	3.17	4.5	7.08	3.68	5.03	5.19	12.5	4.72	8.3	0.32	6.66	3.2	41	5.4
Barium	169	255	583	345	237	348	674	395	357	50.8	438	223		340
Cadmium	0.522	1.33	2.25	1.22	1.13	2.44	3.16	1.53	1.35	0.32	1.12	0.781	39	1.4
Chromium, T	72.4	140	274	78.2	85.9	317	185	267	179	50	574	817		253
Copper	112	256	648	270	215	830	528	624	378	68.9	812	777	1500	460
Lead	27.9	43.1	123	39.1	38.2	138	99.8	37.3	33.5	61.7	44.2	32.8	300	60
Mercury	0.379	0.508	1.74	1.19	0.8	0.627	2.15	1.24	0.538	0.068	0.83	0.579	17	0.89
Molybdenum	7	12	24	15	9.3	1.84	74	23	15	3.4	20	14		18.2
Nickel	65.1	191	239	85.4	62.7	271	267	341	232	65.7	870	**879**	420	297
Potassium	1340	2160	4420	1120	998	1490	3300	2130	1320	269	2400	1930		1906
Selenium	1.36	2.75	5.31	3.26	3.31	4.92	5.02	2.56	2.04	0.3	2.73	1.84	100	2.95
Silver	8.28	8.44	26.3	14.8	10.4	12.5	26.6	12.5	9.09	2.06	11.9	13.9		13
Zinc	314	1120	2130	1140	625	2660	1600	795	577	103	812	528	2800	1034

2006 BELT PRESS CAKE ANALYSIS

	JAN (mg/kg) 1/12/2006	FEB (mg/kg) 2/14/2006	MAR (mg/kg) 3/22/2006	APR (mg/kg) 4/20/2006	MAY (mg/kg) 5/9/2006	JUN (mg/kg) 6/14/2006	JUL (mg/kg) 7/25/2006	AUG (mg/kg) 8/29/2006	SEP (mg/kg) 9/12/2006	OCT (mg/kg) 10/4/2006	NOV (mg/kg) 11/14/2006	DEC (mg/kg) 12/12/2006	AVG
pH	5.69	6.42	5.38	7.2	5.78	5.97	5.5	6.33	6.4	5.98	5.58	5.31	5.96
Percent Sol:	23.4	32.8	30.7	28.6	22.9	23.9	28.9	31.5	29.9	26.4	27.5	29.8	28.0
Ammonia Nit:	12000	2497	5080	3290	11100	5736	9140	5091	4030	4125	3330	1970	5616
Total Nitro<	23300	15320	20640	6479	40540	44895	27600	6194	12050	27295	38500	23600	23868
Nitrates	27.1	<1.5	5	3.2	<.5	2	6.33	1.05	0.66	3.52	0.54	1.81	5.1
Phosphorus	17000	11000	12000	16000	19000	14000	14000	11000	14000	18080	17000	12000	14590
PCB's	<.12	<.15	<.16	<.17	<.087	<.21	<.18	<.16	<.17	<.19	<.18	<.17	#DIV/0!

METALS	JAN Dry Wt (mg/kg)	FEB Dry Wt (mg/kg)	MAR Dry Wt (mg/kg)	APR Dry Wt (mg/kg)	MAY Dry Wt (mg/kg)	JUN Dry Wt (mg/kg)	JUL Dry Wt (mg/kg)	AUG Dry Wt (mg/kg)	SEP Dry Wt (mg/kg)	OCT Dry Wt (mg/kg)	NOV Dry Wt (mg/kg)	DEC Dry Wt (mg/kg)	Conc. Limits	AVG
Arsenic	3.76	5.51	4.04	3.53	3.65	3.5	5.74	6.95	10.3	6.64	4.44	5.68	41	5.3
Barium	314	200	259	317	367	320	313	273	268	379	353	332		308
Cadmium	<.1	0.496	0.67	1.69	1.43	1.03	1.66	1.27	1.29	3.14	1.36	1.58	39	1.4
Chromium, T<	1840	552	871	866	1300	928	1080	1560	1890	915	1590	1930		1277
Copper	1350	740	732	939	918	668	1070	1160	1240	1220	1280	996	1500	1026
Lead	44.2	35.1	37.9	109	44.9	37.6	48.6	52.6	40.8	98.3	49.3	36.6	300	53
Mercury	0.749	0.442	0.657	0.489	0.506	0.47	0.955	1.45	1.13	0.754	0.544	0.135	17	0.69
Molybdenum	20	7.7	12	18	20	15	26	24	19	17	12	8.5		16.6
Nickel	**1510**	**850**	**933**	**897**	**945**	**716**	**1290**	**1600**	**1620**	**1160**	1350	**1410**	420	1190
Potassium	2950	1030	2140	2430	4430	4090	1140	883	1230	7680	2210	1240		2621
Selenium	3.3	1.26	1.87	3.48	1.75	2.47	2.26	2.07	3	3.83	3.69	2.4	100	2.62
Silver	12.1	6.44	10.8	12	18.7	14.2	11.9	11.6	8.34	11.7	15	14		12
Zinc	895	459	689	720	585	667	764	712	661	828	624	609	2800	684

McCoy && McCoy Laboratories, Inc.
P. O. Box

Madisonville, KY

www.mccoylabs.com

Lexington KY 859-299-7775
Paducah KY 270-444-6547
Madisonville KY 270-821-7375
Pikeville KY 606-432-3104

D.Wolfe@mccoylabs.com

Bowling Green Municipal Util
Attn: Heather Stringfield
PO Box 10300
Bowling Green KY 42102-7300

Batch # : 08121633
Received: 12/16/2008
Reported: 01/07/2009
01/07/2009
Client: BO6267

Analysis

AG41051 Centrifuge Cake Collected: 12/16/2008

Test Description	Analyzed	By	Method	Result	Units	Report	Note
% Solids Mdv	12/19/2008	ALH	SM 2540 G	26.2	%		
Total Volatile Solids % By Weight Mdv	12/22/2008	ALH	SM 2540 G	61.2	%		
Ammonia as N in Solid Mdv	01/06/2009	DDP	SM 4500 NH3	12000	mg/kg	6.7	
Fecal Coliform, (MPN) Solid Dry Weight	12/22/2008	DRM	SM 9221 E*	611000	#/1 gram	10	
Potassium Solid ICP/MS Mdv	12/23/2008	MST	SW 6010 B	3940 DQ	mg/kg	28.3	
Arsenic Solid ICP/MS Mdv	12/23/2008	MST	SW 6020	6.35	mg/kg	0.567	
Cadmium Solid ICP/MS Mdv	12/23/2008	MST	SW 6020	1.71 D	mg/kg	0.567	
Chromium Solid ICP/MS Mdv	12/23/2008	MST	SW 6020	96.1 D	mg/kg	0.567	
Copper Solid ICP/MS Mdv	12/23/2008	MST	SW 6020	277 D	mg/kg	0.567	
Lead Solid ICP/MS Mdv	12/23/2008	MST	SW 6020	33.7	mg/kg	0.567	
Mercury Solid ICP/MS Mdv	12/23/2008	MST	SW 6020	0.0567 U	mg/kg	0.0567	
Molybdenum Solid ICP/MS Mdv	12/23/2008	MST	SW 6020	19	mg/kg	1.4	
Nickel Solid ICP/MS Mdv	12/23/2008	MST	SW 6020	76.2 D	mg/kg	0.567	
Phosphorus Solid ICP/MS Mdv	12/23/2008	MST	SW 6020	22000 D	mg/kg	140	
Selenium Solid ICP/MS Mdv	12/23/2008	MST	SW 6020	1.11 D	mg/kg	0.567	
Zinc Solid ICP/MS Mdv	12/23/2008	MST	SW 6020	649 D	mg/kg	0.567	
pH , Soil Mdv	12/18/2008	DJK	SW 9045	6.12	Std. units		
Nitrate as N, Solid Mdv	12/18/2008	DMH	SW 9056	4 U	mg/kg	4	

McCoy && McCoy Laboratories, Inc.
P. O. Box

Madisonville, KY

www.mccoylabs.com

Lexington KY 859-299-7775
Paducah KY 270-444-6547
Madisonville KY 270-821-7375
Pikeville KY 606-432-3104

D.Wolfe@mccoylabs.com

Bowling Green Municipal Util
Attn: Heather Stringfield
PO Box 10300
Bowling Green KY 42102-7300

Batch # : 08121633
Received: 12/16/2008
Reported: 01/07/2009
01/07/2009
Client: BO6267

Analysis

AG41052 Finished Dry Cake Collected: 12/16/2008

Test Description	Analyzed	By	Method	Result	Units	Report	Note
% Solids Mdv	12/19/2008	ALH	SM 2540 G	97.0	%		
Total Volatile Solids % By Weight Mdv	12/22/2008	ALH	SM 2540 G	32.6	%		
Ammonia as N in Solid Mdv	01/06/2009	DDP	SM 4500 NH3	300	mg/kg	2.0	
Fecal Coliform, (MPN) Solid Dry Weight	12/22/2008	DRM	SM 9221 E*	165000	#/1 gram	10	
Potassium Solid ICP/MS Mdv	12/23/2008	MST	SW 6010 B	1670 DQ	mg/kg	0.864	
Arsenic Solid ICP/MS Mdv	12/23/2008	MST	SW 6020	2.41 D	mg/kg	0.173	
Cadmium Solid ICP/MS Mdv	12/23/2008	MST	SW 6020	0.797 D	mg/kg	0.173	
Chromium Solid ICP/MS Mdv	12/23/2008	MST	SW 6020	38.4 D	mg/kg	0.173	
Copper Solid ICP/MS Mdv	12/23/2008	MST	SW 6020	105 D	mg/kg	0.173	
Lead Solid ICP/MS Mdv	12/23/2008	MST	SW 6020	14.2 D	mg/kg	0.173	
Mercury Solid ICP/MS Mdv	12/23/2008	MST	SW 6020	0.131 D	mg/kg	0.0173	
Molybdenum Solid ICP/MS Mdv	12/23/2008	MST	SW 6020	7.0 D	mg/kg	0.43	
Nickel Solid ICP/MS Mdv	12/23/2008	MST	SW 6020	30.0 D	mg/kg	0.173	
Phosphorus Solid ICP/MS Mdv	01/02/2009	MST	SW 6020	8500 D	mg/kg	43	
Selenium Solid ICP/MS Mdv	12/23/2008	MST	SW 6020	0.173 U	mg/kg	0.173	
Zinc Solid ICP/MS Mdv	01/02/2009	MST	SW 6020	276 D	mg/kg	1.73	
pH , Soil Mdv	12/18/2008	DJK	SW 9045	6.05	Std. units		
Nitrate as N, Solid Mdv	12/18/2008	DMH	SW 9056	1	mg/kg	1	

Sample Qualifier
D - Results reported from dilution.
Q - Laboratory control sample outside acceptance limits.
U - Non-detected at the reported detect limit.

Submitted By:

Doug Wolfe, Director of Laboratory Services

The analyses reported above have been determined by protocols that meet or exceed the requirements of NELAC. Methods listed with an "*" are not part of this accreditation. Call Doug Wolfe at 270-821-7375 for any questions concerning this analysis report.