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SECTION 01 11 00 – BASE BID AND OPTIONS

BASE BIDS				
Item No.	CLIN No.	Description	Included in Base Bid	Option to be priced
	CLIN Item No. 0001	All work associated with the renovation of the Cullum Hall and its supporting service utilities as indicated in the corresponding construction documents and specifications.		Not Applicable
	CLIN Item No. 0002	All work associated with the removal of ACM. See the abatement plans. 0002AA Asbestos in the Fire Doors 0002AB Asbestos in Floor Tile (estimated Quantity) 0002AC Asbestos in Roofing Mastic and Felt (estimated Quantity)	See Hazmat Report and Hazmat Drawings H-1B2; H-1B1; H-100; H-200; H-300	Not Applicable
	CLIN Item No. 0003	All work associated with the removal of rock (ie trenches, service yard excavation, etc.) as per 1,034 cubic yards of rock removal. (estimated Quantity) Provide Unit Price.	See Structural Narrative and Structural Drawings S-001; S-002; SD-100; SD-101; S-100; S100.1; S-101; S-301; S-501; S-502 See Civil Drawings CD101, CG101, CU101, C-502, C-504, C-505	Not Applicable
	CLIN Item No. 0004	Turnover of O/M manuals and As-Builts.		Not Applicable
	CLIN Item No. 0005	Mechanical Yard: All work associated with the yard structures and site development including the permanent structures, screen, retaining wall, not equipment. This applies to slab, retaining wall and steel structural (architectural and structural drawings). Not included anything not code required (not HVAC, fire pump) Statutory Limit of $2M	Mechanical Yard CLIN includes all new structural foundations, concrete and steel work, screens, ladders, railings etc. in the North Service Yard. Not included in the CLIN are repairs to existing site retaining walls and stairs, new Mechanical and Electrical equipment, Fire Pump, Electrical manhole or ductbank. See sheets A-109,; A-109.1, A-109.2, S-100, S-101 and S-102; CS101, CG101, CU101, C-201, C-506.	Not Applicable

OPTIONS				
Item No.	CLIN No.	Description	Included in Base Bid	Option to be priced
Add Alt #1	CLIN Item No. 0006	Full roof replacement.	Removal and replacement of gutters and copper roofing at the eaves of the building as indicated on the drawings.	Not Applicable
Add Alt #1	CLIN Item No. 0006AA	All work associated with a full roof replacement.	Not Applicable	In addition to Base Bid, remove existing batten seam copper roofing, flashings, snow guards, wood battens, underlayment, and coverboards down to exiting roof deck. Provide temporary watertight protection over attic floor. Provide terra cotta tile roofing system including vertical wood stringer, horizontal and vertical furring, through bolts, rigid insulation, sheet underlayment, and coverboard. Provide new snow guard system. Drawings AD-140.A, A-145.A, A-511.A, A-512.A
Add Alt #1:	CLIN Item No. 0006AB	Salvage value for copper.	Not included	Provide salvage value for copper removed as part of the Alternate. See Drawings AD-140.A and Specifications 07 62 13.
Add Alt #1:	CLIN Item No. 0006AC	Asbestos in Roofing Mastic and Felt (estimated Quantity)	Not included	Abate Asbestos containing roofing mastic and felt underlayment below copper roofing. See Hazmat Report.
Add Alt #2	CLIN Item No. 0007	All work associated with cleaning 100% of Gneiss Masonry.	Clean gneiss masonry in areas indicated. See Drawings A-200, A-210, A-220, and A-230 and Specifications 04 03 00	In addition to areas in the Base Bid, clean all gneiss masonry. See Drawings A-200, A-210, A-220, and A-230 and Specifications 04 03 00.
Add Alt #3	CLIN Item No. 0008	All work associated with Ballroom Globe fixture type (F) Full Restoration.	See Electrical Drawings EL-602; EL-603	Not Applicable.
Add Alt #4	CLIN Item No. 0009	All work associated with exchanging the Linoleum Flooring with Epoxy Resin Flooring.	Drawings: I-001, I-100.B2, I-100.B1, I-401, I-402, I-501 Interior Finish Material Binders for physical samples	Drawings: I-001, I-100.B2.A, I-100.B1.A, I-401, I-402, I-502 Interior Finish Material Binders for physical samples

Add Alt # 5	CLIN Item No. 0010	Security – All work associated with CFCI IDS including but not limited to head-end equipment, cabling, devices, integration, and testing.	Conduit, junction boxes, enclosures and other items to create a complete pathway system.	See TY-Series Drawings (1B2, 1B1, 110, 120, 130), and T-603, and Specifications 28 08 10 and 28 10 05.
Add Alt # 6	CLIN Item No. 0011	Security – All work associated with CFCI ACS (Card Reader by Hirsch) including but not limited to head-end equipment, cabling, devices, integration, and testing.	Conduit, junction boxes, enclosures and other items to create a complete pathway system.	See TY-Series Drawings (1B2, 1B1, 110, 120, 130), and T-603, and Specifications 28 08 10 and 28 10 05
Add Alt #7	CLIN Item No. 0012	Wireless Communications/Antennas – All work associated with CFCI DAS including but not limited to head-end equipment, cabling, devices, integration, and testing.	Conduit, junction boxes, enclosures and other items to create a complete pathway system.	See TI-Series Drawings (1B2, 1B1, 110, 120, 130), and T-604, and Specifications 28 08 10 and 28 10 05
Add Alt #8	CLIN Item No. 0013	Wireless - All work associated with the installation and testing of network wireless access points including but not limited to: CFCI WAP cables GFCI WAP devices.	Conduit, junction boxes, enclosures and other items to create a complete pathway system.	See TN-Series Drawings (1B3, 1B2, 1B1, 110, 120, 130), TN401, TN402, and T-601, and Specifications 27 05 28.36 40 and 27 10 00
Add Alt #9	CLIN Item No. 0014	Communications – All work associated with the installation and testing of network infrastructure in Cullum Hall, including but not limited to: CFCI UPS for TER/TR; CFCI Surge protectors for TER/TR; CFCI Patch cords for TER/TR; CFCI Horizontal and backbone inside plant cable.	Conduit, junction boxes, enclosures and other items to create a complete pathway system.	See TN-Series Drawings (1B3, 1B2, 1B1, 110, 120, 130), TN401, TN402, and T-601, and Specifications 27 05 28.36 40 and 27 10 00
Add Alt #10	CLIN Item No. 0015	Outside Plant Fiber Optic Cable - All work associated with installation of fiber from Davis Hall and Bldg 600 to Cullum Hall.	Not Applicable	See TS-101, TS-102, and Specification 33 82 00
Add Alt #11	CLIN Item No. 0016	Ductbank - All work associated with installation of ductbank for the fiber from Davis Hall and Bldg 600 to Cullum Hall.	Not Applicable	See TS-101 and Specification 33 82 00
Add Alt #12	CLIN Item No. 0017	Radio and PA System – All work associated work with installation of the radio and PA system. (27 51 00) (wires and headend system and pathway only)	Conduit, junction boxes, enclosures and other items to create a complete pathway system.	See TI-Series Drawings (1B2, 1B1, 110, 120, 130), and T-605, and Specification 27 51 16

The drawings and specs listed above are for guidance but are not all inclusive.

SECTION 01 33 00

SUBMITTAL PROCEDURES
08/18

PART 1 GENERAL

1.1 SUMMARY

1.1.1 Submittal Information

The Contracting Officer may request submittals in addition to those specified when deemed necessary to adequately describe the work covered in the respective sections. Each submittal is to be complete and in sufficient detail to allow ready determination of compliance with contract requirements.

Units of weights and measures used on all submittals are to be the same as those used in the contract drawings.

1.1.2 Project Type

The Contractor's Quality Control (CQC) System Manager are to check and approve all items before submittal and stamp, sign, and date indicating action taken. Proposed deviations from the contract requirements are to be clearly identified. Include within submittals items such as: Contractor's, manufacturer's, or fabricator's drawings; descriptive literature including (but not limited to) catalog cuts, diagrams, operating charts or curves; test reports; test cylinders; samples; O&M manuals (including parts list); certifications; warranties; and other such required submittals.

1.1.3 Submission of Submittals

Schedule and provide submittals requiring Government approval before acquiring the material or equipment covered thereby. Pick up and dispose of samples not incorporated into the work in accordance with manufacturer's Safety Data Sheets (SDS) and in compliance with existing laws and regulations.

1.2 DEFINITIONS

1.2.1 Submittal Descriptions (SD)

Submittal requirements are specified in the technical sections. Examples and descriptions of submittals identified by the Submittal Description (SD) numbers and titles follow:

SD-01 Preconstruction Submittals

Submittals that are required prior to or at the start of construction (work) or the next major phase of the construction on a multiphase contract.

Preconstruction Submittals include schedules and a tabular list of locations, features, and other pertinent information regarding products, materials, equipment, or components to be used in the work.

Certificates Of Insurance

Surety Bonds

List Of Proposed Subcontractors

List Of Proposed Products

Baseline Network Analysis Schedule (NAS)

Submittal Register

Schedule Of Prices Or Earned Value Report

Accident Prevention Plan

Work Plan

Quality Control (QC) plan

Environmental Protection Plan

SD-02 Shop Drawings

Drawings, diagrams and schedules specifically prepared to illustrate some portion of the work.

Diagrams and instructions from a manufacturer or fabricator for use in producing the product and as aids to the Contractor for integrating the product or system into the project.

Drawings prepared by or for the Contractor to show how multiple systems and interdisciplinary work will be coordinated.

SD-03 Product Data

Catalog cuts, illustrations, schedules, diagrams, performance charts, instructions and brochures illustrating size, physical appearance and other characteristics of materials, systems or equipment for some portion of the work.

Samples of warranty language when the contract requires extended product warranties.

SD-04 Samples

Fabricated or unfabricated physical examples of materials, equipment or workmanship that illustrate functional and aesthetic characteristics of a material or product and establish standards by which the work can be judged.

Color samples from the manufacturer's standard line (or custom color samples if specified) to be used in selecting or approving colors for the project.

Field samples and mock-ups constructed on the project site establish standards ensuring work can be judged. Includes assemblies or portions of assemblies that are to be incorporated into the project and those that will be removed at conclusion of the work.

SD-05 Design Data

Design calculations, mix designs, analyses or other data pertaining to a part of work.

Design submittals, design substantiation submittals and extensions of design submittals.

SD-06 Test Reports

Report signed by authorized official of testing laboratory that a material, product or system identical to the material, product or system to be provided has been tested in accord with specified requirements. Unless specified in another section, testing must have been within three years of date of contract award for the project.

Report that includes findings of a test required to be performed on an actual portion of the work or prototype prepared for the project before shipment to job site.

Report that includes finding of a test made at the job site or on sample taken from the job site, on portion of work during or after installation.

Investigation reports

Daily logs and checklists

Final acceptance test and operational test procedure

SD-07 Certificates

Statements printed on the manufacturer's letterhead and signed by responsible officials of manufacturer of product, system or material attesting that the product, system, or material meets specification requirements. Must be dated after award of project contract and clearly name the project.

Document required of Contractor, or of a manufacturer, supplier, installer or Subcontractor through Contractor. The document purpose is to further promote the orderly progression of a portion of the work by documenting procedures, acceptability of methods, or personnel qualifications.

Confined space entry permits

Text of posted operating instructions

SD-08 Manufacturer's Instructions

Preprinted material describing installation of a product, system or material, including special notices and (SDS)concerning impedances, hazards and safety precautions.

SD-09 Manufacturer's Field Reports

Documentation of the testing and verification actions taken by manufacturer's representative at the job site, in the vicinity of the

job site, or on a sample taken from the job site, on a portion of the work, during or after installation, to confirm compliance with manufacturer's standards or instructions. The documentation must be signed by an authorized official of a testing laboratory or agency and state the test results; and indicate whether the material, product, or system has passed or failed the test.

Factory test reports.

SD-10 Operation and Maintenance Data

Data provided by the manufacturer, or the system provider, including manufacturer's help and product line documentation, necessary to maintain and install equipment, for operating and maintenance use by facility personnel.

Data required by operating and maintenance personnel for the safe and efficient operation, maintenance and repair of the item.

Data incorporated in an operations and maintenance manual or control system.

SD-11 Closeout Submittals

Documentation to record compliance with technical or administrative requirements or to establish an administrative mechanism.

Submittals required for Guiding Principle Validation (GPV) or Third Party Certification (TPC).

Special requirements necessary to properly close out a construction contract. For example, Record Drawings and as-built drawings. Also, submittal requirements necessary to properly close out a major phase of construction on a multi-phase contract.

1.2.2 Approving Authority

Office or designated person authorized to approve the submittal.

1.2.3 Work

As used in this section, on-site and off-site construction required by contract documents, including labor necessary to produce submittals, construction, materials, products, equipment, and systems incorporated or to be incorporated in such construction. In exception, excludes work to produce SD-01 submittals.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals with an "S" are for inclusion in the Sustainability Notebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with this section.

SD-01 Preconstruction Submittals

Submittal Register; G, RO

1.4 SUBMITTAL CLASSIFICATION

1.4.1 Government Approved (G)

Government approval is required for extensions of design, critical materials, variations, equipment whose compatibility with the entire system must be checked, and other items as designated by the Government.

Government approval is required for any variations from the Solicitation or the Accepted Proposal and for other items as designated by the Government.

Within the terms of the Contract Clause SPECIFICATIONS AND DRAWINGS FOR CONSTRUCTION, submittals are considered to be "shop drawings."

1.4.2 For Information Only

Submittals not requiring Government approval will be for information only. Within the terms of the Contract Clause SPECIFICATIONS AND DRAWINGS FOR CONSTRUCTION, they are not considered to be "shop drawings."

1.4.3 Sustainability Reporting Submittals (S)

Submittals for Guiding Principle Validation (GPV) or Third Party Certification (TPC) are indicated with an "S" designation. These submittals are for information only and for use as specified in Section 01 33 29 SUSTAINABILITY REPORTING.

Schedule submittals for these items throughout the course of construction as provided; do not wait until closeout.

1.5 PREPARATION

1.5.1 Transmittal Form

Use the ENG Form 4025-R transmittal form for submitting both Government-approved and information-only submittals. Submit in accordance with the instructions on the reverse side of the form. These forms are included in the RMS CM software that the Contractor is required to use for this contract. Properly complete this form by filling out all the heading blank spaces and identifying each item submitted. Exercise special care to ensure proper listing of the specification paragraph and sheet number of the contract drawings pertinent to the data submitted for each item.

1.5.2 Submittal Format

1.5.2.1 Format of SD-01 Preconstruction Submittals

When the submittal includes a document that is to be used in the project, or is to become part of the project record, other than as a submittal, do not apply the Contractor's approval stamp to the document itself, but to a separate sheet accompanying the document.

Provide data in the unit of measure used in the contract documents.

1.5.2.2 Format for SD-02 Shop Drawings

Provide shop drawings not less than 8 1/2 by 11 inches nor more than 30 by 42 inches, except for full-size patterns or templates. Prepare drawings to accurate size, with scale indicated, unless another form is required. Ensure drawings are suitable for reproduction and of a quality to produce clear, distinct lines and letters, with dark lines on a white background.

a. Include the nameplate data, size, and capacity on drawings. Also include applicable federal, military, industry, and technical society publication references.

b. Dimension drawings, except diagrams and schematic drawings. Prepare drawings demonstrating interface with other trades to scale. Use the same unit of measure for shop drawings as indicated on the contract drawings. Identify materials and products for work shown.

Present shop drawings sized 8 1/2 by 11 inches as part of the bound volume for submittals. Present larger drawings in sets. Submit an electronic copy of drawings in PDF format.

1.5.2.2.1 Drawing Identification

Include on each drawing the drawing title, number, date, and revision numbers and dates, in addition to information required in paragraph IDENTIFYING SUBMITTALS.

Number drawings in a logical sequence. Each drawing is to bear the number of the submittal in a uniform location next to the title block. Place the Government contract number in the margin, immediately below the title block, for each drawing.

Reserve a blank space on the right-hand side of each sheet for the Government disposition stamp.

1.5.2.3 Format of SD-03 Product Data

Present product data submittals for each section as a complete, bound volume. Include a table of contents, listing the page and catalog item numbers for product data.

Indicate, by prominent notation, each product that is being submitted; indicate the specification section number and paragraph number to which it pertains.

1.5.2.3.1 Product Information

Supplement product data with material prepared for the project to satisfy the submittal requirements where product data does not exist. Identify this material as developed specifically for the project, with information and format as required for submission of SD-07 Certificates.

Provide product data in units used in the Contract documents. Where product data are included in preprinted catalogs with another unit, submit the dimensions in contract document units, on a separate sheet.

1.5.2.3.2 Standards

Where equipment or materials are specified to conform to industry or

technical-society reference standards of such organizations as the American National Standards Institute (ANSI), ASTM International (ASTM), National Electrical Manufacturer's Association (NEMA), Underwriters Laboratories (UL), or Association of Edison Illuminating Companies (AEIC), submit proof of such compliance. The label or listing by the specified organization will be acceptable evidence of compliance. In lieu of the label or listing, submit a certificate from an independent testing organization, competent to perform testing, and approved by the Contracting Officer. State on the certificate that the item has been tested in accordance with the specified organization's test methods and that the item complies with the specified organization's reference standard.

1.5.2.3.3 Data Submission

Collect required data submittals for each specific material, product, unit of work, or system into a single submittal that is marked for choices, options, and portions applicable to the submittal. Mark each copy of the product data identically. Partial submittals will not be accepted for expedition of the construction effort.

Submit the manufacturer's instructions before installation.

1.5.2.4 Format of SD-04 Samples

1.5.2.4.1 Sample Characteristics

Furnish samples in the following sizes, unless otherwise specified or unless the manufacturer has prepackaged samples of approximately the same size as specified:

a. Sample of Equipment or Device: Full size.

b. Sample of Materials Less Than 2 by 3 inches: Built up to 8 1/2 by 11 inches.

c. Sample of Materials Exceeding 8 1/2 by 11 inches: Cut down to 8 1/2 by 11 inches and adequate to indicate color, texture, and material variations.

d. Sample of Linear Devices or Materials: 10 inch length or length to be supplied, if less than 10 inches. Examples of linear devices or materials are conduit and handrails.

e. Sample Volume of Nonsolid Materials: Pint. Examples of nonsolid materials are sand and paint.

f. Color Selection Samples: 2 by 4 inches. Where samples are specified for selection of color, finish, pattern, or texture, submit the full set of available choices for the material or product specified. Sizes and quantities of samples are to represent their respective standard unit.

g. Sample Panel: 4 by 4 feet.

h. Sample Installation: 100 square feet.

1.5.2.4.2 Sample Incorporation

Reusable Samples: Incorporate returned samples into work only if so specified or indicated. Incorporated samples are to be in undamaged condition at the time of use.

Recording of Sample Installation: Note and preserve the notation of any area constituting a sample installation, but remove the notation at the final clean-up of the project.

1.5.2.4.3 Comparison Sample

Samples Showing Range of Variation: Where variations in color, finish, pattern, or texture are unavoidable due to nature of the materials, submit sets of samples of not less than three units showing extremes and middle of range. Mark each unit to describe its relation to the range of the variation.

1.5.2.5 Format of SD-05 Design Data

Provide design data and certificates on 8 1/2 by 11 inch paper. Provide a bound volume for submittals containing numerous pages.

1.5.2.6 Format of SD-06 Test Reports

Provide reports on 8 1/2 by 11 inch paper in a complete bound volume.

By prominent notation, indicate each report in the submittal. Indicate the specification number and paragraph number to which each report pertains.

1.5.2.7 Format of SD-07 Certificates

Provide design data and certificates on 8 1/2 by 11 inch paper. Provide a bound volume for submittals containing numerous pages.

1.5.2.8 Format of SD-08 Manufacturer's Instructions

Present manufacturer's instructions submittals for each section as a complete, bound volume. Include the manufacturer's name, trade name, place of manufacture, and catalog model or number on product data. Also include applicable federal, military, industry, and technical-society publication references. If supplemental information is needed to clarify the manufacturer's data, submit it as specified for SD-07 Certificates.

Submit the manufacturer's instructions before installation.

1.5.2.8.1 Standards

Where equipment or materials are specified to conform to industry or technical-society reference standards of such organizations as the American National Standards Institute (ANSI), ASTM International (ASTM), National Electrical Manufacturer's Association (NEMA), Underwriters Laboratories (UL), or Association of Edison Illuminating Companies (AEIC), submit proof of such compliance. The label or listing by the specified organization will be acceptable evidence of compliance. In lieu of the label or listing, submit a certificate from an independent testing organization, competent to perform testing, and approved by the Contracting Officer. State on the certificate that the item has been

tested in accordance with the specified organization's test methods and that the item complies with the specified organization's reference standard.

1.5.2.9 Format of SD-09 Manufacturer's Field Reports

Provide reports on 8 1/2 by 11 inch paper in a complete bound volume.

By prominent notation, indicate each report in the submittal. Indicate the specification number and paragraph number to which each report pertains.

1.5.2.10 Format of SD-10 Operation and Maintenance Data (O&M)

Comply with the requirements specified in Section 01 78 23 OPERATION AND MAINTENANCE DATA for O&M Data format.

1.5.2.11 Format of SD-11 Closeout Submittals

When the submittal includes a document that is to be used in the project or is to become part of the project record, other than as a submittal, do not apply the Contractor's approval stamp to the document itself, but to a separate sheet accompanying the document.

Provide data in the unit of measure used in the contract documents.

1.5.3 Source Drawings for Shop Drawings

1.5.3.1 Source Drawings

The entire set of source drawing files (DWG) will not be provided to the Contractor. Request the specific Drawing Number for the preparation of shop drawings. Only those drawings requested to prepare shop drawings will be provided. These drawings are provided only after award.

1.5.3.2 Terms and Conditions

Data contained on these electronic files must not be used for any purpose other than as a convenience in the preparation of construction data for the referenced project. Any other use or reuse is at the sole risk of the Contractor and without liability or legal exposure to the Government. The Contractor must make no claim, and waives to the fullest extent permitted by law any claim or cause of action of any nature against the Government, its agents, or its subconsultants that may arise out of or in connection with the use of these electronic files. The Contractor must, to the fullest extent permitted by law, indemnify and hold the Government harmless against all damages, liabilities, or costs, including reasonable attorney's fees and defense costs, arising out of or resulting from the use of these electronic files.

These electronic source drawing files are not construction documents. Differences may exist between the source drawing files and the corresponding construction documents. The Government makes no representation regarding the accuracy or completeness of the electronic source drawing files, nor does it make representation to the compatibility of these files with the Contractor hardware or software. The Contractor is responsible for determining if any conflict exists. In the event that a conflict arises between the signed and sealed construction documents prepared by the Government and the furnished source drawing files, the

signed and sealed construction documents govern. Use of these source drawing files does not relieve the Contractor of the duty to fully comply with the contract documents, including and without limitation the need to check, confirm and coordinate the work of all contractors for the project. If the Contractor uses, duplicates or modifies these electronic source drawing files for use in producing construction data related to this contract, remove all previous indication of ownership (seals, logos, signatures, initials and dates).

1.5.4 Electronic File Format

Provide submittals in electronic format, with the exception of material samples required for SD-04 Samples items. In addition to the electronic submittal, provide three hard copies of the submittals when requested. Compile the submittal file as a single, complete document, to include the Transmittal Form described within. Name the electronic submittal file specifically according to its contents, and coordinate the file naming convention with the Contracting Officer. Electronic files must be of sufficient quality that all information is legible. Use PDF as the electronic format, unless otherwise specified or directed by the Contracting Officer. Generate PDF files from original documents with bookmarks so that the text included in the PDF file is searchable and can be copied. If documents are scanned, optical character resolution (OCR) routines are required. Index and bookmark files exceeding 30 pages to allow efficient navigation of the file. When required, the electronic file must include a valid electronic signature or a scan of a signature.

E-mail electronic submittal documents smaller than 10MB to an e-mail address as directed by the Contracting Officer. Provide electronic documents over 10 MB on an optical disc or through an electronic file sharing system such as the ADoD SAFE Web Application located at the following website: https://safe.apps.mil/.

If hard copies are requested in addition to the electronic copy, the date at which the submittal review process starts is the date that the hard copy is in receipt by the Government.

1.6 QUANTITY OF SUBMITTALS

1.6.1 Number of SD-01 Preconstruction Submittal Copies

Unless otherwise specified, submit three sets of administrative submittals.

1.6.2 Number of SD-02 Shop Drawing Copies

The primary submittals' delivery method is electronic, see Electronic File Format paragraph for requirements. However, if hard copies are requested, submit three copies of submittals of shop drawings requiring review and approval by a QC organization. Submit three copies of shop drawings requiring review and approval by the Contracting Officer.

1.6.3 Number of SD-03 Product Data Copies

Submit in compliance with quantity requirements specified for shop drawings.

1.6.4 Number of SD-04 Samples

a. Submit two samples, or two sets of samples showing the range of

variation, of each required item. One approved sample or set of samples will be retained by the approving authority and one will be returned to the Contractor.

b. Submit one sample panel or provide one sample installation where directed. Include components listed in the technical section or as directed.

c. Submit one sample installation, where directed.

d. Submit one sample of nonsolid materials.

1.6.5 Number of SD-05 Design Data Copies

Submit in compliance with quantity requirements specified for shop drawings.

1.6.6 Number of SD-06 Test Report Copies

Submit in compliance with quantity and quality requirements specified for shop drawings, other than field test results that will be submitted with QC reports.

1.6.7 Number of SD-07 Certificate Copies

Submit in compliance with quantity requirements specified for shop drawings.

1.6.8 Number of SD-08 Manufacturer's Instructions Copies

Submit in compliance with quantity requirements specified for shop drawings.

1.6.9 Number of SD-09 Manufacturer's Field Report Copies

Submit in compliance with quantity and quality requirements specified for shop drawings other than field test results that will be submitted with QC reports.

1.6.10 Number of SD-10 Operation and Maintenance Data Copies

Submit three copies of O&M data to the Contracting Officer for review and approval.

1.6.11 Number of SD-11 Closeout Submittals Copies

Unless otherwise specified, submit three sets of administrative submittals.

1.7 INFORMATION ONLY SUBMITTALS

Submittals without a "G" designation must be certified by the QC manager and submitted to the Contracting Officer for information-only. Approval of the Contracting Officer is not required on information only submittals. The Contracting Officer will mark "receipt acknowledged" on submittals for information and will return only the transmittal cover sheet to the Contractor. Normally, submittals for information only will not be returned. However, the Government reserves the right to return unsatisfactory submittals and require the Contractor to resubmit any item found not to comply with the contract. This does not relieve the

Contractor from the obligation to furnish material conforming to the plans and specifications; will not prevent the Contracting Officer from requiring removal and replacement of nonconforming material incorporated in the work; and does not relieve the Contractor of the requirement to furnish samples for testing by the Government laboratory or for check testing by the Government in those instances where the technical specifications so prescribe.

1.8 PROJECT SUBMITTAL REGISTER

A sample Project Submittal Register showing items of equipment and materials for when submittals are required by the specifications is provided as "Appendix A - Submittal Register."

1.8.1 Submittal Management

Prepare and maintain a submittal register, as the work progresses. Do not change data that is output in columns (c), (d), (e), and (f) as delivered by Government; retain data that is output in columns (a), (g), (h), and (i) as approved. As an attachment, provide a submittal register showing items of equipment and materials for which submittals are required by the specifications. This list may not be all-inclusive and additional submittals may be required. Maintain a submittal register for the project in accordance with Section 01 45 00.15 10 RESIDENT MANAGEMENT SYSTEM CONTRACTOR MODE(RMS CM). The Government will provide the initial submittal register in electronic format with the following fields completed, to the extent that will be required by the Government during subsequent usage.

Column (c): Lists specification section in which submittal is required.

Column (d): Lists each submittal description (SD Number. and type, e.g., SD-02 Shop Drawings) required in each specification section.

Column (e): Lists one principal paragraph in each specification section where a material or product is specified. This listing is only to facilitate locating submitted requirements. Do not consider entries in column (e) as limiting the project requirements.

Thereafter, the Contractor is to track all submittals by maintaining a complete list, including completion of all data columns and all dates on which submittals are received by and returned by the Government.

1.8.2 Preconstruction Use of Submittal Register

Submit the submittal register. Include the QC plan and the project schedule. Verify that all submittals required for the project are listed and add missing submittals. Coordinate and complete the following fields on the register submitted with the QC plan and the project schedule:

Column (a) Activity Number: Activity number from the project schedule.

Column (g) Contractor Submit Date: Scheduled date for the approving authority to receive submittals.

Column (h) Contractor Approval Date: Date that Contractor needs approval of submittal.

Column (i) Contractor Material: Date that Contractor needs material delivered to Contractor control.

1.8.3 Contractor Use of Submittal Register

Update the following fields in the Government-furnished submittal register program or equivalent fields in the program used by the Contractor with each submittal throughout the contract.

Column (b) Transmittal Number: List of consecutive, Contractor-assigned numbers.

Column (j) Action Code (k): Date of action used to record Contractor's review when forwarding submittals to QC.

Column (l) Date submittal transmitted.

Column (q) Date approval was received.

1.8.4 Approving Authority Use of Submittal Register

Update the following fields:

Column (b) Transmittal Number: List of consecutive, Contractor-assigned numbers.

Column (l) Date submittal was received.

Column (m) through (p) Dates of review actions.

Column (q) Date of return to Contractor.

1.8.5 Action Codes

1.8.5.1 Contractor Action Codes

DESIGN BID BUILD SUBMITTALS			
Submittal Classifications shown in UFGS Sections	Submittal Classification	Corresponding SpecsIntact Submittal Register Code which is populated in the SI Submittal Register. Software Limitations: (The software shows one character delineation in the SpecsIntact Submittal Register)	RMS – The following Submittal Classifications are populated in RMS when the SpecsIntact Submittal Data File is pulled into RMS)

DESIGN BID BUILD SUBMITTALS			
G	Submittal requires Government Approval	G	GA
BLANK	Submittal is For Information Only (FIO)	BLANK	FIO
S	Submittal is for documentation of Sustainable requirements	S	S/FIO
AE	Submittal requires the Designer of Record approval	AE	DA

1.8.6 Delivery of Copies

Submit an updated electronic copy of the submittal register to the Contracting Officer with each invoice request. Provide an updated Submittal Register monthly regardless of whether an invoice is submitted.

1.9 VARIATIONS

Variations from contract requirements require Contracting Officer approval pursuant to contract Clause FAR 52.236-21 Specifications and Drawings for Construction, and will be considered where advantageous to the Government.

1.9.1 Considering Variations

Discussion of variations with the Contracting Officer before submission will help ensure that functional and quality requirements are met and minimize rejections and resubmittals. When contemplating a variation that results in lower cost, consider submission of the variation as a Value Engineering Change Proposal (VECP).

Specifically point out variations from contract requirements in transmittal letters. Failure to point out variations may cause the Government to require rejection and removal of such work at no additional cost to the Government.

1.9.2 Proposing Variations

When proposing variation, deliver a written request to the Contracting Officer, with documentation of the nature and features of the variation and why the variation is desirable and beneficial to Government. Include the DOR's written analysis and approval. If lower cost is a benefit, also include an estimate of the cost savings. In addition to documentation required for variation, include the submittals required for the item. Clearly mark the proposed variation in all documentation.

Check the column "variation" of ENG Form 4025-R for submittals that include variations proposed by the Contractor. Set forth in writing the reason for any variations and note such variations on the submittal. The Government reserves the right to rescind inadvertent approval of

submittals containing unnoted variations.

1.9.3 Warranting that Variations are Compatible

When delivering a variation for approval, the Contractor warrants that this contract has been reviewed to establish that the variation, if incorporated, will be compatible with other elements of work.

1.9.4 Review Schedule Extension

In addition to the normal submittal review period, a period of 14 calendar days will be allowed for the Government to consider submittals with variations.

1.10 SCHEDULING

Schedule and submit concurrently product data and shop drawings covering component items forming a system or items that are interrelated. Submit pertinent certifications at the same time. No delay damages or time extensions will be allowed for time lost in late submittals. Allow an additional 21 calendar days for review and approval of submittals for refrigeration and HVAC control systems.

a. Coordinate scheduling, sequencing, preparing, and processing of submittals with performance of work so that work will not be delayed by submittal processing. The Contractor is responsible for additional time required for Government reviews resulting from required resubmittals. The review period for each resubmittal is the same as for the initial submittal.

b. Submittals required by the contract documents are listed on the submittal register. If a submittal is listed in the submittal register but does not pertain to the contract work, the Contractor is to include the submittal in the register and annotate it "N/A" with a brief explanation. Approval by the Contracting Officer does not relieve the Contractor of supplying submittals required by the contract documents but that have been omitted from the register or marked "N/A."

c. Resubmit the submittal register and annotate it monthly with actual submission and approval dates. When all items on the register have been fully approved, no further resubmittal is required.

Contracting Officer review will be completed within 30 calendar days after the date of submission.

1.11 GOVERNMENT APPROVING AUTHORITY

When the approving authority is the Contracting Officer, the Government will:

a. Note the date on which the submittal was received.

b. Review submittals for approval within the scheduling period specified and only for conformance with project design concepts and compliance with contract documents.

c. Identify returned submittals with one of the actions defined in

paragraph REVIEW NOTATIONS and with comments and markings appropriate for the action indicated.

Upon completion of review of submittals requiring Government approval, stamp and date submittals. Electronic copies of the submittal will be retained by the Contracting Officer and distributed to the Contractor unless specified otherwise. The Contracting Officer will retain one copy of the submittal, and two copies of the submittal will be returned to the Contractor when hard copy submittals are requested.

1.11.1 Review Notations

Submittals will be returned to the Contractor with the following notations:

a. Submittals marked "approved" or "accepted" authorize proceeding with the work covered.

b. Submittals marked "approved as noted" or "approved, except as noted, resubmittal not required," authorize proceeding with the work covered provided that the Contractor takes no exception to the corrections.

c. Submittals marked "not approved," "disapproved," or "revise and resubmit" indicate incomplete submittal or noncompliance with the contract requirements or design concept. Resubmit with appropriate changes. Do not proceed with work for this item until the resubmittal is approved.

d. Submittals marked "not reviewed" indicate that the submittal has been previously reviewed and approved, is not required, does not have evidence of being reviewed and approved by Contractor, or is not complete. A submittal marked "not reviewed" will be returned with an explanation of the reason it is not reviewed. Resubmit submittals returned for lack of review by Contractor or for being incomplete, with appropriate action, coordination, or change.

e. Submittals marked "receipt acknowledged" indicate that submittals have been received by the Government. This applies only to "information-only submittals" as previously defined.

1.12 DISAPPROVED SUBMITTALS

Make corrections required by the Contracting Officer. If the Contractor considers any correction or notation on the returned submittals to constitute a change to the contract drawings or specifications, give notice to the Contracting Officer as required under the FAR clause titled CHANGES. The Contractor is responsible for the dimensions and design of connection details and the construction of work. Failure to point out variations may cause the Government to require rejection and removal of such work at the Contractor's expense.

If changes are necessary to submittals, make such revisions and resubmit in accordance with the procedures above. No item of work requiring a submittal change is to be accomplished until the changed submittals are approved.

1.13 APPROVED SUBMITTALS

The Contracting Officer's approval of submittals is not to be construed as a complete check, and indicates only that the general method of

construction, materials, detailing, and other information are satisfactory. the design, general method of construction, materials, detailing, and other information appear to meet the Solicitation and Accepted Proposal.

Approval or acceptance by the Government for a submittal does not relieve the Contractor of the responsibility for meeting the contract requirements or for any error that may exist, because under the Quality Control (QC) requirements of this contract, the Contractor is responsible for ensuring information contained with in each submittal accurately conforms with the requirements of the contract documents.

After submittals have been approved or accepted by the Contracting Officer, no resubmittal for the purpose of substituting materials or equipment will be considered unless accompanied by an explanation of why a substitution is necessary.

1.14 APPROVED SAMPLES

Approval of a sample is only for the characteristics or use named in such approval and is not be construed to change or modify any contract requirements. Before submitting samples, provide assurance that the materials or equipment will be available in quantities required in the project. No change or substitution will be permitted after a sample has been approved.

Match the approved samples for materials and equipment incorporated in the work. If requested, approved samples, including those that may be damaged in testing, will be returned to the Contractor, at its expense, upon completion of the contract. Unapproved samples will also be returned to the Contractor at its expense, if so requested.

Failure of any materials to pass the specified tests will be sufficient cause for refusal to consider, under this contract, any further samples of the same brand or make as that material. The Government reserves the right to disapprove any material or equipment that has previously proved unsatisfactory in service.

Samples of various materials or equipment delivered on the site or in place may be taken by the Contracting Officer for testing. Samples failing to meet contract requirements will automatically void previous approvals. Replace such materials or equipment to meet contract requirements.

1.15 WITHHOLDING OF PAYMENT

Payment for materials incorporated in the work will not be made if required approvals have not been obtained. No payment for materials incorporated in the work will be made unless all required DOR approvals or required Government approvals have been obtained. No payment will be made for any materials incorporated into the work for any conformance review submittals or information-only submittals found to contain errors or deviations from the Solicitation or Accepted Proposal. There will be no partial payment made respective of partial delivery of the As-built/Operations and Maintenance requirements, training, commissioning, punch lists, etc. Payment is made for 100 percent submission of closeout submittals only.

1.16 STAMPS

Certify the submittal data as follows on Form ENG 4025: "I certify that the above submitted items had been reviewed in detail and are correct and in strict conformance with the contract drawings and specifications except as otherwise stated.

_____NAME OF CONTRACTOR _____ SIGNATURE OF CONTRACTOR

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

-- End of Section --

SUBMITTAL REGISTER

CONTRACT NO.

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CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAG # RAPH	CLASSIFICATION	GOVT OR A/E REVWR	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION			APPROVING AUTHORITY					MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
							SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION	DATE FWD TO APPR AUTH/ DATE RCD FROM CONTR	DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION		
(a)	(b)	(c)	(d)	(e)	(f)		(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		01 11 00	SD-01 Preconstruction Submittals															
			Dig Safe Permit	1.10.1														
		01 30 00	SD-01 Preconstruction Submittals															
			View Location Map	1.3	G	RO												
			Progress and Completion	1.4	G	RO												
			Pictures															
			Preconstruction Digital	1.4.4.2														
			Photographs															
			Preconstruction Video Recording	1.4.5.2	G	RO												
			Work to be Performed by the	1.11	G	RO												
			Contractor															
			Eng Form 93	1.22														
			Eng Form 93	1.22														
			SD-04 Samples															
			Construction Color Boards	1.2	G	RO												
			SD-05 Design Data															
			Periodic Construction Video	1.4.5.3														
			Recordings															
			Periodic Construction Digital	1.4.4.3														
			Photographs															
			Final Completion Construction	1.4.5.4														
			Video Recordings															
			SD-07 Certificates															
			Eng Form 93	1.22	G	RO												
			Eng Form 93	1.22	G	RO												
			SD-11 Closeout Submittals															

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(a)	(b)	(c)	(d)	(e)	(f)		(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)		(q)	(r)
		01 30 00	Final Completion Construction	1.4.4.4															
			Digital Photographs																
		01 32 01.00 10	SD-01 Preconstruction Submittals																
			Project Scheduler Qualifications	1.3	G	RO													
			Preliminary Project Schedule	3.4.1	G	RO													
			Initial Project Schedule	3.4.2	G	RO													
			Periodic Schedule Update	3.6.2	G	RO													
			Narrative Report	3.5.2	G	RO													
		01 33 00	SD-01 Preconstruction Submittals																
			Submittal Register	1.8	G	RO													
		01 33 29	SD-01 Preconstruction Submittals																
			Preliminary High Performance	1.5.3.1	G	RO													
			and Sustainable Building Checklist																
			Sustainability Action Plan	1.4.1	G	RO													
			Preliminary Sustainability	1.5.3.1	G	RO													
			eNotebook																
			SD-11 Closeout Submittals																
			Final High Performance and	1.5.3.1	G	RO													
			Sustainable Building Checklist																
			Final Sustainability eNotebook	1.5.3.1	G	RO													
			Amended Final Sustainability	1.5.3.1	G	RO													
			eNotebook																
			Amended Final High	1.5.3.1	G	RO													
			Performance and Sustainable																
			Building Checklist																

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(a)	(b)	(c)	(d)	(e)	(f)		(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		01 33 29	Third Party Certification	3.2	G	RO												
			Certificate, Assessment, or															
			Validation															
		01 35 26	SD-01 Preconstruction Submittals															
			Accident Prevention Plan (APP)	1.7	G	RO												
			SD-06 Test Reports															
			Monthly Exposure Reports	1.4														
			Notifications and Reports	1.12														
			Accident Reports	1.12.2	G	RO												
			LHE Inspection Reports	1.12.3														
			SD-07 Certificates															
			Crane Operators/Riggers	1.6.1.5														
			Standard Lift Plan	1.7.2.2	G	RO												
			Critical Lift Plan	1.7.2.3	G	RO												
			Activity Hazard Analysis (AHA)	1.8														
			Confined Space Entry Permit	1.9.1														
			Hot Work Permit	1.9.1														
			Certificate of Compliance	1.12.4														
			License Certificates	1.14														
			Radiography Operation Planning	1.14.1	G	RO												
			Work Sheet															
			Portable Gauge Operations	1.14.1	G	RO												
			Planning Worksheet															
		01 35 91	SD-01 Preconstruction Submittals															
			Historic Treatment Sub-schedule	1.4.2.2	G	RO												
			Photographic Documentation	1.10	G	RO												

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(a)	(b)	(c)	(d)	(e)	(f)		(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)		(q)	(r)
		01 35 91	Historic Treatment Program	3.3	G	RO													
			Alternative Methods and	1.11	G	RO													
			Materials																
			Fire-Prevention Plan	3.2.1	G	RO													
			SD-05 Design Data																
			Progress Photos	1.10	G	AE													
		01 45 00.00 10	SD-01 Preconstruction Submittals																
			Contractor Quality Control (CQC)	3.2	G	RO													
			Plan																
			SD-06 Test Reports																
			Verification Statement	3.9.2															
			SD-07 Certificates																
			Qcr Report	3.10	G	RO													
		01 45 20.00 18	SD-01 Preconstruction Submittals																
			Test Plan List	1.3	G	RO													
		01 45 35	SD-07 Certificates																
			Fabrication Plant	2.1															
			AC472 Accreditation	2.1															
			Certificate of Compliance	2.1															
			Testing and Inspection Agency	1.4	G	AE													
			Qualifications																
			Special Inspector	1.6	G	AE													
			SD-11 Closeout Submittals																
			Comprehensive Final Report	2.1	G	AE													
		01 50 00	SD-01 Preconstruction Submittals																
			Construction Site Plan	1.4	G	RO													

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(a)	(b)	(c)	(d)	(e)	(f)		(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		01 50 00	Traffic Control Plan	3.5.1	G	RO												
			Haul Road Plan	2.2.1	G	RO												
			Contractor Computer	1.7.1.4	G	RO												
			Cybersecurity Compliance															
			Statements															
			Contractor Temporary Network	1.7.6	G	RO												
			Cybersecurity Compliance															
			Statements															
			SD-07 Certificates															
			Backflow Tester	1.5.1														
			Backflow Preventers	1.5														
		01 57 19	SD-01 Preconstruction Submittals															
			Preconstruction Survey	1.5.1														
			Solid Waste Management Permit	1.10	G	RO												
			Regulatory Notifications	1.5.2	G	RO												
			Environmental Protection Plan	1.6	G	RO												
			Stormwater Pollution Prevention	3.2.1.1	G	RO												
			Plan															
			Stormwater Notice of Intent	3.2.1.2	G	RO												
			Dirt and Dust Control Plan	1.6.9.1	G	RO												
			Employee Training Records	1.5.5	G	RO												
			Environmental Manager	1.5.4	G	RO												
			Qualifications															
			SD-06 Test Reports															
			Inspection Reports	3.2.1.3														

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(a)	(b)	(c)	(d)	(e)	(f)		(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		01 57 19	Monthly Solid Waste Disposal	1.10.1	G	RO												
			Report															
			SD-07 Certificates															
			Employee Training Records	1.5.5	G	RO												
			Certificate of Competency	1.5.5.1														
			Erosion and Sediment Control	1.5.5														
			Inspector															
			SD-11 Closeout Submittals															
			Stormwater Pollution Prevention	3.2.1.4	G	RO												
			Plan Compliance Notebook															
			Stormwater Notice of Termination	3.2.1.5	G	RO												
			Waste Determination	3.7.1	G	RO												
			Documentation															
			Disposal Documentation for	3.7.3.6	G	RO												
			Hazardous and Regulated Waste															
			Assembled Employee Training	1.5.5	G	RO												
			Records															
			Solid Waste Management Permit	1.10	G	RO												
			Project Solid Waste Disposal	3.7.2.1	G	RO												
			Documentation Report															
			Hazardous Waste/Debris	3.7.3.1	G	RO												
			Management															
			Regulatory Notifications	1.5.2	G	RO												
			Sales Documentation	3.7.2.1	G	RO												
		01 58 00	SD-02 Shop Drawings															
			Sign Legend Orders	1.4.1	G	RO												

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(a)	(b)	(c)	(d)	(e)	(f)		(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		01 74 19	SD-01 Preconstruction Submittals															
			Construction Waste Management	1.6	G	RO												
			Plan															
			SD-06 Test Reports															
			Quarterly Reports	1.8.2														
			Annual Report	1.8.3														
			SD-11 Closeout Submittals															
			Final Construction Waste	1.9	S													
			Diversion Report															
		01 78 00	SD-03 Product Data															
			Warranty Management Plan	1.8.1														
			Warranty Tags	1.8.5														
			Spare Parts Data	1.6														
			SD-08 Manufacturer's Instructions															
			Instructions	1.8.1														
			SD-10 Operation and Maintenance															
			Data															
			Operation and Maintenance	3.7	G	RO												
			Manuals															
			SD-11 Closeout Submittals															
			As-Built Drawings	3.1	G	RO												
			Record Drawings	3.3	G	RO												
			Record Model	2.2	G	RO												
			As-Built Record of Equipment	1.8.1														
			and Materials															
			Final Approved Shop Drawings	3.4	G	RO												

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(a)	(b)	(c)	(d)	(e)	(f)		(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		01 78 00	Construction Contract Specifications	3.5	G	RO												
			Certification of EPA Designated Items	2.3	G	RO												
			Certification Of USDA Designated Items	2.4	G	RO												
			Interim DD FORM 1354	3.9.1	G	RO												
			Checklist for DD FORM 1354	3.9.2	G	RO												
			High Performance And Sustainable Building (HPSB) Checklist	3.9.2	G	RO												
		01 78 23	SD-10 Operation and Maintenance Data															
			O&M Database	1.3	G	RO												
			Training Plan	3.1.1	G	RO												
			Training Outline	3.1.3	G	RO												
			Training Content	3.1.2	G	RO												
			SD-11 Closeout Submittals															
			Training Video Recording	3.1.4	G	RO												
			Validation of Training Completion	3.1.6	G	RO												
		01 78 24.00 10	SD-01 Preconstruction Submittals															
			Facility Data Project Execution Plan	1.4.1														
			SD-10 Operation and Maintenance Data															

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ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAG # RAPH	CLASSIFICATION	GOVT OR A/E REVWR	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION			APPROVING AUTHORITY					MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
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(a)	(b)	(c)	(d)	(e)	(f)		(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)		(q)	(r)
		01 78 24.00 10	Facility Data Workbook,	3.1	G	RO													
			Construction Progress																
			Facility Document Set,	3.1	G	RO													
			Construction Progress																
			SD-11 Closeout Submittals																
			Facility Data Workbook,	3.2	G	RO													
			Construction Final																
			Facility Document Set,	1.4.3	G	RO													
			Construction Final																
			Facility Document Set,	3.2	G	RO													
			Construction Final																
		01 91 00.15 10	SD-01 Preconstruction Submittals																
			Commissioning Firm	1.7	G	DO													
			Lead Commissioning Specialist	1.7.1	G	DO													
			Technical Commissioning	1.7.2	G	DO													
			Specialists																
			Commissioning Firm's Contract	1.7	G	DO													
			SD-06 Test Reports																
			Design Review Report	1.5.2	G	DO													
			Interim Construction Phase	3.1.3.1	G	DO													
			Commissioning Plan																
			Final Construction Phase	3.1.3.2	G	DO													
			Commissioning Plan																
			Template Building Envelope	3.1.3.1.2	G	DO													
			Inspection Checklists																

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		01 91 00.15 10	Building Envelope Inspection	3.1.5.2	G	DO												
			Checklists															
			Pre-Functional Checklists	3.1.5.3	G	DO												
			Issues Log	1.9														
			Commissioning Report	3.2	G	DO												
			Post-Construction Trend Log	3.3.1	G	DO												
			Report															
			Performance Verification Tests	1.5.2	G	DO												
			Performance Verification Test	1.5.1	G	DO												
			Report															
			Functional Performance Test	3.1.5.6.4.3	G	RO												
			Procedures															
			SD-07 Certificates															
			Certificate of Readiness	1.10	G	DO												
			SD-10 Operation and Maintenance															
			Data															
			Training Plan	3.1.6	G	RO												
			Training Attendance Rosters	3.1.6	G	RO												
			Systems Manual	3.1.7	G	DO												
			Systems Manual	3.1.7	G	DO												
			Maintenance and Service Life	3.1.8	G	DO												
			Plans															
			SD-11 Closeout Submittals															
			Final Commissioning Report	3.2	S	DO												
			Final Construction Phase	3.1.3.2	S													
			Commissioning Plan															

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		02 41 00	SD-01 Preconstruction Submittals																
			Demolition Plan	1.2.2	G	AE													
			Deconstruction Plan	1.2.1.4	G	AE													
			Existing Conditions	1.9															
			SD-07 Certificates																
			Notification	1.6	G	AE													
			SD-11 Closeout Submittals																
			Receipts	3.3.4															
		02 42 91	SD-01 Preconstruction Submittals																
			Work Plan	1.2	G	AE													
		02 81 00	SD-03 Product Data																
			Packaging Notifications	2.1.1															
			Hazardous Waste Management Plan	3.1	G	RO													
			Onsite Hazardous Waste Management	3.2	G	RO													
			Notices of Non-Compliance and Notices of Violation	3.3															
			SD-06 Test Reports																
			Recordkeeping	3.7	G	RO													
			Exception Report	3.7	G	RO													
			Spill Response	3.8															
			SD-07 Certificates																
			Transportation and Disposal Coordinator	1.4.1	G	RO													
			Training	1.4.2	G	RO													

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		02 81 00	Certification	1.4.3														
			Shipping Documents and	3.3.3	G	RO												
			Packagings Certification															
			Security Plan	3.3.4														
			Certificates of Disposal	3.3.5														
			Waste Minimization	3.6														
		02 82 00	SD-03 Product Data															
			Amended Water	1.2.2	G	RO												
			Safety Data Sheets (SDS) for All	1.3.9	G	RO												
			Materials															
			Encapsulants	2.1	G	RO												
			Respirators	3.1.2.1	G	RO												
			Local Exhaust Equipment	3.1.7	G	RO												
			Pressure Differential Automatic	3.1.7	G	RO												
			Recording Instrument															
			Vacuums	3.1.8	G	RO												
			Glovebags	3.1.10	G	RO												
			SD-06 Test Reports															
			Air Sampling Results	1.5.5	G	RO												
			Pressure Differential Recordings	1.5.6	G	RO												
			for Local Exhaust System															
			Clearance Sampling	3.2.11.4	G	RO												
			Asbestos Disposal Quantity	3.3.3.2	G	RO												
			Report															
			SD-07 Certificates															
			Employee Training	1.3.4	G	RO												

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		02 82 00	Notifications	1.3.5	G	RO												
			Respiratory Protection Program	1.3.7	G	RO												
			Asbestos Hazard Abatement Plan	1.3.10	G	RO												
			Testing Laboratory	1.3.11	G	RO												
			Landfill Approval	1.3.12	G	RO												
			Delivery Tickets	1.3.12	G	RO												
			Waste Shipment Records	1.3.12	G	RO												
			Transporter Certification	1.3.13	G	RO												
			Medical Certification	1.3.14	G	RO												
			Private Qualified Person	1.5.1	G	RO												
			Documentation															
			Competent Person	1.5.2	G	RO												
			Worker's License	1.5.3	G	RO												
			Contractor's License	1.5.4	G	RO												
			Federal, State or Local Citations	1.5.9	G	RO												
			on Previous Projects															
			Equipment Used to Contain	3.1	G	RO												
			Airborne Asbestos Fibers															
			Water Filtration Equipment	3.1.3.2	G	RO												
			Vacuums	3.1.8	G	RO												
			Ventilation Systems	3.1.8	G	RO												
			SD-11 Closeout Submittals															
			Permits and Licenses	1.3.5	G	RO												
			Notifications	1.3.5	G	RO												
			Respirator Program Records	1.3.7.1	G	RO												

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		02 82 00	Protective Clothing	1.5.7	G	RO												
			Decontamination Quality Control															
			Records															
			Protective Clothing	1.5.8														
			Decontamination Facility															
			Notification															
			Rental Equipment	1.7.1	G	RO												
		02 83 00	SD-01 Preconstruction Submittals															
			Certified Industrial Hygienist	1.2.5														
			Competent Person	1.5.1.1	G	RO												
			Training Certification	1.5.1.2	G	RO												
			Medical Examinations	1.5.2.3	G	RO												
			Lead, Cadmium, Chromium	1.5.2.7	G	RO												
			Waste Management Plan															
			Licenses, Permits and	1.5.4	G	RO												
			Notifications															
			Lead, Cadmium, Chromium	1.5.2.2	G	RO												
			Compliance Plan															
			Lead, Cadmium, Chromium	3.1.1.5	G	RO												
			Compliance Plan															
			Initial Sample Results	3.4.1.1	G	RO												
			Written Evidence of TSD	3.5.2.1	G	RO												
			Approval															
			SD-03 Product Data															
			Respirators	1.6.1	G	RO												
			Vacuum Filters	1.6.4	G	RO												

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		02 83 00	Negative Air Pressure System	1.6.7	G	RO												
			Materials and Equipment	2.1	G	RO												
			Expendable Supplies	2.1.1	G	RO												
			Local Exhaust Equipment	3.1.1.4	G	RO												
			Pressure Differential Automatic	3.1.1.4	G	RO												
			Recording Instrument															
			Pressure Differential Log	3.1.1.5	G	RO												
			SD-06 Test Reports															
			Sampling and Analysis	1.3.3	G	RO												
			Pressure Differential Recordings	1.5.3	G	RO												
			For Local Exhaust System															
			SD-07 Certificates															
			Testing Laboratory	1.5.1.3	G	RO												
			Third Party Consultant	1.5.1.4	G	RO												
			Qualifications															
			Occupant Notification	1.5.4	G	RO												
			Notification of the	3.1.1.1	G	RO												
			Commencement of LBP Hazard															
			Abatement															
			Clearance Certification	3.5.1.1	G	RO												
			SD-11 Closeout Submittals															
			Hazardous Waste Manifest	3.5.2.1	G	RO												
			Turn-In Documents or Weight	3.5.2.1	G	RO												
			Tickets															
		02 84 16	SD-07 Certificates															
			Qualifications of CIH	1.8.1	G	RO												

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		02 84 16	Training Certification	1.8.1	G	RO												
			PCB and Lamp Removal Work	1.8.2	G	RO												
			Plan															
			PCB and Lamp Disposal Plan	1.8.3	G	RO												
			SD-11 Closeout Submittals															
			Transporter certification	3.5.2	G	RO												
			Certification of Decontamination	3.2.4														
			Certificate of Disposal and/or	3.5.2.1														
			recycling															
			DD Form 1348-1	3.5.3.2														
			Testing results	3.3.1														
		02 85 00	SD-01 Preconstruction Submittals															
			Ventilation System Mold	1.2.26	G	RO												
			Remediator (VSMR) Qualifications															
			Mold Assessment Report	3.7.3.1	G	RO												
			Mold Remediation Plan	1.4.1.2	G	RO												
			Respiratory Protection Program	1.4.1.3	G	RO												
			Worker Records	1.4.1.4														
			NYS Mold Assessor License	1.4.1.5	G	RO												
			NYS Mold Remediation	1.4.1.6	G	RO												
			Supervisor Qualifications															
			NYS Licensed Mold Remediation	3.7.1	G	RO												
			Contractor															
			SD-03 Product Data															
			Disinfectants or Biocide	1.2.11	G	RO												
			Sanitizing Solutions															

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		02 85 00	Fungicidal Agents, (EPA)	1.2.14	G	RO												
			Personal Protective Equipment	1.2.21	G	RO												
			(PPE)															
			Pressure Differential Measuring	1.2.24														
			Instrument															
			Safety Data Sheets (SDS) for All	2.2	G	RO												
			Materials															
			Dehumidifiers	3.1.4														
			Air Filtration Units	3.1.5														
			SD-06 Test Reports															
			Licensed NYS Mold Assessor	1.4.3	G	RO												
			Daily Reports															
			SD-11 Closeout Submittals															
			Submittals at Completion of	1.4.4	G	RO												
			Remediation Work															
		03 30 00	SD-01 Preconstruction Submittals															
			Concrete Curing Plan	1.6.3.1														
			Quality Control Plan	1.6.6	G	RO												
			Quality Control Personnel	1.6.7	G	RO												
			Certifications															
			Quality Control Organizational	1.6.7														
			Chart															
			Laboratory Accreditation	1.6.9	G	RO												
			Form Removal Schedule	1.6.2.1	G	RO												
			Maturity Method Data	3.3.8														
			SD-02 Shop Drawings															

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		03 30 00	Formwork	1.6.2.1														
			Steel Reinforcement Shop	1.6.2.2	G	AE												
			Drawings															
			Sleeves and Openings Shop	1.6.2.2	G	AE												
			Drawings															
			Construction and Contraction	1.6.2.2	G	AE												
			Joints Shop Drawings															
			SD-03 Product Data															
			Joint Sealants	2.4.5														
			Joint Filler	2.4.4														
			Formwork Materials	2.1														
			Recycled Aggregate Materials	2.3.3.3														
			Cementitious Materials	2.3.1														
			Vapor Retarder and Vapor Barrier	2.4.6														
			Vapor Retarder and Vapor Barrier	3.5.2														
			Concrete Curing Materials	2.4.1														
			Reinforcement	2.6														
			Liquid Chemical Floor Hardeners	2.4.3.1														
			and Sealers															
			Admixtures	2.3.4														
			Reinforcing Fibers	2.6.5														
			Mechanical Reinforcing Bar	2.6.2														
			Connectors															
			Waterstops	2.2.2														
			Local/Regional Materials	1.8.1														

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		03 30 00	Biodegradable Form Release	2.2.3														
			Agent															
			Pumping Concrete	1.6.3.2														
			Finishing Plan	1.6.3.3														
			Nonshrink Grout	2.4.2														
			SD-04 Samples															
			Slab Finish Sample	1.6.5.1														
			Surface Finish Samples	1.6.5.2														
			SD-05 Design Data															
			Concrete Mix Design	1.6.1.2	G	AE												
			SD-06 Test Reports															
			Concrete Mix Design	1.6.1.2	G	AE												
			Fly Ash	1.6.4.1														
			Pozzolan	1.6.4.1														
			Slag Cement	1.6.4.2														
			Aggregates	1.6.4.3														
			Fiber-Reinforced Concrete	1.6.4.4	G	AE												
			Tolerance Report	3.10.2.1														
			Compressive Strength Tests	3.14.2.3	G	AE												
			Unit Weight of Structural	3.14.2.4														
			Concrete															
			Chloride Ion Concentration	3.14.2.5														
			Air Content	2.5.2														
			Slump Tests	3.14.2.1														
			Water	2.3.2														
			SD-07 Certificates															

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		03 30 00	Certification Letter from	1.6	G	AE												
			Contractor's Professional Engineer															
			Reinforcing Bars	2.6.1														
			Welder Qualifications	1.9														
			VOC Content for Form Release	1.6.3.4														
			Agents, Curing Compounds, and															
			Concrete Penetrating Sealers															
			Safety Data Sheets	1.6.3.5														
			Forest Stewardship Council	1.8.2														
			(FSC) Certification															
			Field Testing Technician and	1.6.7.2														
			Testing Agency															
			SD-08 Manufacturer's Instructions															
			Liquid Chemical Floor Hardeners	2.4.3.1														
			and Sealers															
			Joint Sealants	2.4.5														
			Curing Compound	2.4.1														
		04 03 00	SD-01 Preconstruction Submittals															
			Quality Control Plan	1.6.1	G	AE												
			Project Training Program	1.6.1	G	RO												
			Qualifications	1.6.2	G	AE												
			SD-02 Shop Drawings															
			Photographic Documentation	1.6.5	G	AE												
			Structural Upgrades	3.4.2	G	RO												
			SD-03 Product Data															
			Qualifications	1.6.2														

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		04 03 00	Cleaning and Restoration	1.6.7.1	G	AE												
			Methods															
			Cleaning Materials	2.1	G	AE												
			Biocides	3.3.5.2	G	AE												
			Replacement Mortar	2.2.2.2	G	AE												
			Mortar Mix	2.4	G	AE												
			Repair Materials	2.2	G	AE												
			Repair Materials	2.2	G	AE												
			Mock-ups	1.6.8.1	G	AE												
			SD-05 Design Data															
			Structural Upgrades	3.4.2	G	RO												
			SD-06 Test Reports															
			Testing and Matching	2.2.2.1														
			SD-07 Certificates															
			Repair Materials	2.2														
		04 20 00	SD-02 Shop Drawings															
			Cut CMU	3.3.4.1	G	AE												
			Detail Drawings	3.4.1.1	G	AE												
			New and Enlarged Openings	1.3.1	G	AE												
			Drawings															
			SD-03 Product Data															
			Hot Weather Procedures	1.5.1	G	AE												
			Cold Weather Procedures	1.5.2	G	AE												
			Clay or Shale Brick	2.2.2	G	AE												
			Salvaged Brick	3.3.2.1	G	AE												
			Cement	2.2.3.2.1	G	AE												

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		04 20 00	Cementitious Materials	2.4.1.1	G	AE												
			SD-04 Samples															
			Mock-Up Panel	1.3.2.1	G	AE												
			Clay or Shale Brick	2.2.2	G	AE												
			Concrete Masonry Units (CMU)	2.2.3.2	G	AE												
			Admixtures for Masonry Mortar	2.4.1.3	G	AE												
			Anchors, Ties, and Bar Positioners	2.6.2	G	AE												
			Joint Reinforcement	2.6.3	G	AE												
			SD-05 Design Data															
			Masonry Compressive Strength	2.1.2	G	AE												
			Fire-Rated Concrete Masonry Units	2.2.3.3														
			Bracing Calculations	3.2.5	G	AE												
			SD-06 Test Reports															
			Fire-Rated Concrete Masonry Units	2.2.3.3														
			Field Testing of Mortar	3.6.1.1														
			Field Testing of Grout	3.6.1.2														
			Prism Tests	3.6.1.3														
			SD-07 Certificates															
			Special Masonry Inspector Qualifications	1.3.3														
			Clay or Shale Brick	2.2.2														
			Concrete Masonry Units (CMU)	2.2.3.2														
			Precast Concrete Units	2.2.4														

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		04 20 00	Cementitious Materials	2.4.1.1															
			Admixtures for Masonry Mortar	2.4.1.3															
			Admixtures for Grout	2.4.2.2															
			Anchors, Ties, and Bar	2.6.2															
			Positioners																
			Joint Reinforcement	2.6.3															
			SD-08 Manufacturer's Instructions																
			Admixtures for Masonry Mortar	2.4.1.3															
			Admixtures for Grout	2.4.2.2															
			SD-10 Operation and Maintenance																
			Data																
			Take-Back Program	3.8															
			SD-11 Closeout Submittals																
			Clay Units	2.2.2.1.2	S														
			Recycled Content	2.2.3.2.2	S														
		05 12 00	SD-01 Preconstruction Submittals																
			Erection Bracing Drawings	1.4.1.1	G	AE													
			SD-02 Shop Drawings																
			Fabrication Drawing	1.4.2	G	AE													
			Field Work Shop Drawings	1.4.3	G	AE													
			Erection Bracing Drawings	1.4.1.1	G	AE													
			Record Shop Drawings	1.4.6	G	AE													
			SD-03 Product Data																
			Shop Primer	2.6.2															
			Welding Electrodes and Rods	2.4.1															
			Direct Tension Indicator Washers	3.4.1.1															

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		05 12 00	Non-Shrink Grout	2.4.2															
			Tension Control Bolts	3.4.2															
			Recycled Content for Structural	2.2.1	S														
			Steel																
			Recycled Content for Structural	2.2.2	S														
			Steel Tubing																
			Recycled Content for Steel Pipe	2.2.3	S														
			SD-05 Design Data																
			Design Calculations	1.4.4	G	AE													
			SD-06 Test Reports																
			Class B Coating	2.6.2															
			Bolts, Nuts, and Washers	2.3															
			Weld Inspection Reports	3.9.1.2															
			Direct Tension Indicator Washer	3.9.2.1															
			Inspection Reports																
			Bolt Testing Reports	3.9.3.1															
			Embrittlement Test Reports	3.9.4															
			SD-07 Certificates																
			Contractor's Professional	1.4.5.1	G	AE													
			Engineer Certification Letter																
			Steel	2.2	G	AE													
			Bolts, Nuts, and Washers	2.3	G	AE													
			Galvanizing	2.5															
			AISC Structural Steel Fabricator	1.3	G	AE													
			Quality Certification																

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		05 12 00	AISC Structural Steel Erector	1.3	G	AE												
			Quality Certification															
			Welding Procedures and	1.4.5.2	G	AE												
			Qualifications															
			Welding Electrodes and Rods	2.4.1	G	AE												
			Certified Welding Inspector	3.9.1.1	G	AE												
			NDT Technician	3.9.1.2														
			Welding Procedure Specifications	3.6	G	AE												
			(WPS)															
		05 30 00	SD-02 Shop Drawings															
			Fabrication Drawings	1.3.5	G	AE												
			SD-03 Product Data															
			Accessories	2.2														
			Deck Units	2.1	G	AE												
			Galvanizing Repair Paint	3.2.4.1														
			Mechanical Fasteners	2.2.11														
			Touch-Up Paint	2.1.4														
			Welding Equipment	1.3.4														
			Welding Rods and Accessories	1.3.4														
			Recycled Content of Steel	2.1	S													
			Products															
			SD-05 Design Data															
			Deck Units	2.1	G	AE												
			SD-07 Certificates															
			Certification Letter from	1.3.2	G	AE												
			Contractor's Professional Engineer															

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		05 30 00	Powder-Actuated Tool Operator	1.3.3															
			Welder Qualifications	1.3.4															
			Welding Procedures	1.3.4															
			Manufacturer's Certificate	1.3.1															
			Stud Manufacture's Certification	2.2.10															
			Stud Manufacture's Test Reports	2.2.10															
		05 50 13	SD-02 Shop Drawings																
			Installation Drawings	1.6.2	G	RO													
			Fabrication Drawings	1.6.1	G	RO													
			SD-03 Product Data																
			Door Guards	2.8	G	RO													
			SD-05 Design Data																
			Delegated Design Submittal	1.5.1	G	RO													
			Certificates of Compliance	2.1	G	RO													
			Certified Mill	2.2	G	RO													
			Recycled Content	2.1	G	RO													
		05 51 00	SD-02 Shop Drawings																
			Iron and Steel Hardware	2.1	G	AE													
			Steel Shapes, Plates, Bars, and Strips	2.1	G	AE													
			Metal Stair System	2.2.1	G	AE													
			SD-03 Product Data																
			Structural-Steel Plates, Shapes, and Bars	2.4.1	G	AE													
			Structural-Steel Tubing	2.4.2	G	RO													

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		05 51 00	Hot-Rolled Carbon Steel Sheets	2.4.5	G	RO												
			and Strips															
			Cold-Finished Steel Bars	2.4.4	G	RO												
			Hot-Rolled Carbon Steel Bars	2.4.3	G	RO												
			Cold-Rolled Carbon Steel Sheets	2.4.6	G	RO												
			Galvanized Carbon Steel Sheets	2.4.7	G	RO												
			Cold-Drawn Steel Tubing	2.4.8	G	RO												
			Gray Iron Castings	2.4.9	G	RO												
			Malleable Iron Castings	2.4.10	G	AE												
			Concrete Inserts	2.2.1	G	AE												
			Masonry Anchorage Devices	2.3.3	G	RO												
			Protective Coating	2.2.3	G	RO												
			Steel Pan Stairs	2.2.2	G	RO												
			Steel Stairs	2.3.1	G	RO												
			Member and Connection	1.3.3	G	AE												
			Calculations															
			SD-07 Certificates															
			Welding Procedures	1.3.1	G	RO												
			Welder Qualification	1.3.1	G	RO												
			Certification Letter from	1.3.3.1	G	AE												
			Contractor's Professional Engineer															
			SD-08 Manufacturer’s Instructions															
			Structural-Steel Plates, Shapes,	2.4.1	G	RO												
			and Bars															
			Structural-Steel Tubing	2.4.2	G	RO												
			Protective Coating	2.2.3	G	AE												

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		05 51 00	Masonry Anchorage Devices	2.3.3	G	AE												
			Concrete Anchorage Devices	2.3.2	G	AE												
		05 51 33	SD-02 Shop Drawings															
			Ladders	2.3														
			Ship's Ladder	2.3.1														
			SD-03 Product Data															
			Ladders	2.3														
			Ship's Ladder	2.3.1														
			Ladder Safety	2.3														
			SD-07 Certificates															
			Fabricator Certification for Ladder	1.3														
			Assembly															
			Fabricator Certification for Ships	1.3														
			Ladder Assembly															
		05 52 00	SD-02 Shop Drawings															
			Fabrication Drawings	1.2.1	G	AE												
			Iron and Steel Hardware	3.2	G	RO												
			Steel Shapes, Plates, Bars and	3.2	G	RO												
			Strips															
			SD-03 Product Data															
			Structural-Steel Plates, Shapes,	2.3.1	G	RO												
			and Bars															
			Structural-Steel Tubing	2.3.2	G	RO												
			Cold-Finished Steel Bars	2.3.4	G	RO												
			Hot-Rolled Carbon Steel Bars	2.3.3	G	RO												
			Cold-Drawn Steel Tubing	2.3.5	G	RO												

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		05 52 00	Concrete Inserts	2.3.7	G	RO													
			Masonry Anchorage Devices	2.3.8	G	RO													
			Protective Coating	2.2.2	G	RO													
			Steel Railings and Handrails	2.3.10	G	RO													
			Anchorage and Fastening	1.2.1	G	RO													
			Systems																
			Member and Connection	2.1	G	AE													
			Calculations																
			SD-07 Certificates																
			Welding Procedures	1.4.1	G	RO													
			Welder Qualification	1.4.2	G	AE													
			Certification Letter From	1.4.4.1	G	AE													
			Contractor's Professional Engineer																
			SD-08 Manufacturer’s Instructions																
			Installation Instructions	3.2															
		05 52 00.01	SD-02 Shop Drawings																
			Fabrication Drawings	1.3.1	G	AE													
			Iron and Steel Hardware	1.3.1	G	AE													
			Steel Shapes, Plates, Bars and	1.3.1	G	AE													
			Strips																
			SD-03 Product Data																
			Structural-Steel Plates, Shapes,	1.3.1	G	RO													
			and Bars																
			Structural-Steel Tubing	1.3.1	G	AE													
			Cold-Finished Steel Bars	1.3.1	G	AE													
			Hot-Rolled Carbon Steel Bars	1.3.1	G	AE													

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		05 52 00.01	Cold-Drawn Steel Tubing	1.3.1	G	AE												
			Concrete Inserts	1.3.1	G	AE												
			Concrete Inserts	2.1	G	AE												
			Masonry Anchorage Devices	2.5	G	AE												
			Protective Coating	1.3.1	G	AE												
			Steel Railings and Handrails	2.1.2	G	AE												
			Stainless Steel Railing System	1.2	G	AE												
			with Illuminated Sections															
			Anchorage and Fastening	1.3.1	G	AE												
			Systems															
			SD-04 Samples															
			Stainless Steel Railing	2.4	G	AE												
			Stainless Steel Railing	2.4.2	G	AE												
			Steel Railing	2.1.3	G	AE												
			SD-07 Certificates															
			Welding Procedures	1.5.1	G	AE												
			Welder Qualification	1.5.2	G	AE												
			Certification Letter from	1.5.2	G	AE												
			Contractor's Professional Engineer															
		05 72 00	SD-01 Preconstruction Submittals															
			Existing Conditions	1.4.3	G	AE												
			SD-02 Shop Drawings															
			Ornamental Metal Items	2.2.1	G	AE												
			Ornamental Metal Items	3.2	G	AE												
			Installation Drawings	3.2	G	AE												
			Shop and Field Connections	3.2	G	RO												

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		05 72 00	Construction Details	3.2	G	RO													
			SD-03 Product Data																
			Materials	2.1	G	AE													
			Ornamental Metal Items	2.2.1	G	AE													
			Ornamental Metal Items	3.2	G	AE													
			SD-04 Samples																
			Bronze Alloy(s) for repair	2.1.6	G	AE													
			materials and replacement																
			fasteners																
			New steel window grilles	1.2															
			Anchorage Devices and	1.4.1	G	RO													
			Fasteners																
			SD-06 Test Reports																
			Welding Tests	1.4.2	G	RO													
			Laboratory Analysis	1.4.4	G	AE													
			SD-07 Certificates																
			Welding Procedures	1.4.2															
			Ornamental Metal Items	2.2.1	G	RO													
			Ornamental Metal Items	3.2	G	RO													
			Certificates of Welder	1.4.2	G	AE													
			Qualifications																
			SD-08 Manufacturer’s Instructions																
			Bronze Cleaning Materials	2.1.5	G	AE													
			Bronze Materials	2.1.6	G	AE													
			Bronze Protective Coating and	2.1.7	G	AE													
			Patination Products																

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		05 72 00	Preventative Maintenance and	3.6															
			Inspection																
			Maintenance Instructions	3.7															
			Application Methods	3.6															
		06 10 00	SD-02 Shop Drawings																
			Nailing Strips	2.1.1	G	RO													
			SD-03 Product Data																
			Underlayment	2.3															
			Fire-retardant Treatment	1.8															
			SD-06 Test Reports																
			Preservative-treated	1.4.3															
			SD-07 Certificates																
			Certificates of Grade	1.11.1															
			Certified Sustainably Harvested	2.2.1.1	S														
			Plywood Subflooring																
			Certified Sustainably Harvested	2.2.3.1	S														
			Plywood for Other Uses																
			Certified Sustainably Harvested	2.3.2	S														
			Plywood Underlayment																
			Preservative Treatment	1.7															
		06 20 00	SD-02 Shop Drawings																
			Detail Drawings Indicating All	1.3	G	AE													
			Wood Assemblies																
			SD-03 Product Data																
			Wood Products	2.1	G	RO													
			Engineered	2.1.11.1	G	RO													

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		06 20 00	Treated Wood Products	1.4	G	RO												
			Soffits	2.2	G	RO												
			Fascias and Trim	2.3	G	RO												
			Hardware and Accessories	2.8	G	RO												
			VOC Content for Siding	2.1.11	S													
			Recycled Content for	2.1.8	S													
			MDF/Particleboard															
			SD-04 Samples															
			Samples	1.5	G	AE												
			SD-07 Certificates															
			Certificates of Grade	1.7.1.1	G	RO												
			Certified Sustainably Harvested	2.1.3	S													
			Wood for Trim and Frames															
			Certified Sustainably Harvested	2.1.5	S													
			Softwood Plywood															
			Certified Sustainably Harvested	2.1.6	S													
			Hardwood Plywood															
			Certified Sustainably Harvested	2.1.7	S													
			Hardboard															
			Certified Sustainably Harvested	2.1.11	S													
			Siding															
			Indoor Air Quality for Hardwood	2.1.6	S													
			Plywood															
			Indoor Air Quality for MDF and	2.1.8	S													
			Particleboard															

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		06 20 00	Indoor Air Quality for Non-aerosol	2.9.1.2	S													
			Adhesives															
			Indoor Air Quality for Aerosol	2.9.1.2	S													
			Adhesives															
		06 41 16.00 10	SD-02 Shop Drawings															
			Shop Drawings	1.5.2														
			Shop Drawings	2.11														
			Installation	3.1														
			SD-03 Product Data															
			Wood Materials	2.1														
			Wood Finishes	2.9														
			Finish Schedule	2.11.8.3														
			Certification	1.5.3	G	AE												
			SD-04 Samples															
			Plastic Laminates	2.3														
			Cabinet Hardware	2.6														
			SD-07 Certificates															
			Quality Assurance	1.5														
			Laminate Clad Casework	2.9														
			Laminate Clad Casework	3.1														
			SD-11 Closeout Submittals															
			LEED Documentation	1.3	S													
		06 61 16	SD-02 Shop Drawings															
			Detail Drawings	1.5.2	G	AE												
			Installation	3.1	G	RO												
			SD-03 Product Data															

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		06 61 16	Solid Polymer Material	2.1															
			Qualifications	1.5.1															
			Fabrications	2.3															
			Indoor air quality for solid surface	2.2.4	S														
			seam and sealant products																
			SD-04 Samples																
			Material	2.1	G	AE													
			Counter and Vanity Tops	2.3.5	G	AE													
			SD-06 Test Reports																
			Solid Polymer Material	2.1															
			SD-07 Certificates																
			Fabrications	2.3															
			Qualifications	1.5.1															
			Indoor Air Quality for solid	2.1	S														
			surface fabrication products																
			SD-10 Operation and Maintenance																
			Data																
			Clean-up	3.2															
		07 14 00	SD-02 Shop Drawings																
			Fluid-Applied Membrane Roofing	2.2	G	AE													
			and Flashing																
			SD-03 Product Data																
			Fluid-Applied Membrane Roofing	2.2	G	AE													
			and Flashing																
			Membrane Primer	2.4	G	AE													
			Bond Breaker	2.11	G	AE													

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		07 14 00	Aggregate	2.6	G	AE												
			Sealant	2.7	G	AE												
			Sealant Primer	2.8	G	AE												
			Backing Material	2.9	G	AE												
			Moisture Mitigation	2.12	G	AE												
			Fluid-applied Dampproofing	2.14	G	AE												
			SD-06 Test Reports															
			Moisture Test	3.12.1	G	AE												
			Substrate Bond Strength	3.12.2	G	AE												
			Electronic Field Vector Mapping Test	3.12.4	G	AE												
			Flood Test	3.12.5	G	AE												
			SD-07 Certificates															
			Installer's Authorization	1.3	G	AE												
			Manufacturer's Certification	1.3	G	AE												
			SD-11 Closeout Submittals															
			Warranty	1.7														
			Information Card	3.16														
			Instructions To Government Personnel	3.15														
		07 21 23	SD-03 Product Data															
			Sprayed Cellulose acoustical insulation	2.1														
			Recycled Content for Insulation Materials	2.1.2	S													
			SD-07 Certificates															

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		07 21 23	Indoor Air Quality for Insulation	2.1.4	S														
			Materials																
			SD-08 Manufacturer's Instructions																
			Sprayed Cellulose acoustical	2.1															
			insulation																
		07 22 00	SD-02 Shop Drawings																
			Verification of Existing Conditions	1.3															
			SD-03 Product Data																
			Insulation	2.1															
			Cover Board	1.4															
			Asphalt	2.3.3															
			Recycled Content For Insulation	2.1.3	S														
			SD-07 Certificates																
			Installer Qualifications	1.6															
			Indoor Air Quality For Insulation	2.1.4	S														
			SD-08 Manufacturer's Instructions																
			Fasteners	3.2.1															
			Insulation	2.1															
		07 27 36	SD-01 Preconstruction Submittals																
			Qualification of Manufacturer	1.9.1	G	RO													
			Qualification of Installer	1.9.2	G	RO													
			Quality Control Plan	1.10	G	RO													
			Safety Plan	1.10	G	RO													
			Fire Prevention Plan	1.8.1	G	RO													
			Respirator Plan	1.8.2	G	RO													
			SD-02 Shop Drawings																

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		07 27 36	Spray Foam Air Barrier	1.5															
			Foam Air Barrier System	1.10	G	RO													
			Fire-Rated Assemblies	1.5.1	G	RO													
			SD-03 Product Data																
			Closed Cell	2.1.2	G	RO													
			Primers, Adhesives, and Mastics	2.2	G	RO													
			Sealants	2.3	G	RO													
			Safety Data Sheets	1.5.2	G	RO													
			Thermal Barrier Materials	2.1.1	G	RO													
			Ignition Barrier Coatings	2.1.1	G	RO													
			Accessories	2.1.6	G														
			SD-04 Samples																
			Spray Foam Air Barrier	1.5	G	RO													
			SD-06 Test Reports																
			Field Peel Adhesion Test	1.5.4	G	RO													
			Primers	1.5.3	G	RO													
			Fire-Ratings Of ThermalIgnition	1.5.4	G	RO													
			Barrier Materials																
			Flame Spread And Smoke	1.5.4	G	RO													
			Developed Index Ratings Of SPF																
			Products																
			Flame Propagation Of Wall	1.5.4	G	RO													
			Assemblies																
			Site Inspections	3.4.1	G	RO													
			SD-07 Certificates																
			Closed cell	2.1.2	G	RO													

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		07 27 36	Indoor Air Quality for Spray Foam	2.1.5	S														
			Air Barrier																
			SD-08 Manufacturer's Instructions																
			SPF Handling, Storage, and	1.6.1	G	RO													
			Spray Procedures																
			Substrate Preparation	3.2.1	G	RO													
			Thermal Barrier	1.5.1	G	RO													
			Ignition Barrier	1.5.1	G	RO													
			Primers, Adhesives, and Mastics	2.2	G	RO													
			SD-09 Manufacturer's Field																
			Reports																
			Core Samples	1.10															
			Daily Work Record	3.3.2															
		07 32 13	SD-02 Shop Drawings																
			Clay Tile Roofing System	1.7.2	G	AE													
			Snow Guard System	1.7.3	G	AE													
			Roof Hatches	2.8	G	AE													
			Safety Post	2.8.1	G	AE													
			SD-03 Product Data																
			Clay Tile	2.1.1	G	AE													
			Underlayment Membrane	2.2	G	AE													
			Fasteners	2.3	G	AE													
			Sealant	2.6	G	AE													
			Snow Guards	2.7	G	AE													
			Roof Hatches	2.8	G	AE													
			Safety Posts	3.5.8	G	AE													

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		07 32 13	SD-04 Samples															
			Snow Guards	2.7	G	AE												
			Snow Guards	2.7	G	AE												
			SD-06 Test Reports															
			Pullout Test	3.4.1	G	AE												
			SD-07 Certificates															
			Qualifications	1.7.1	G	AE												
			Certification Letter From	1.7.3	G	AE												
			Contractor's Professional Engineer															
			SD-08 Manufacturer's Instructions															
			Installation	3.5	G	AE												
			SD-11 Closeout Submittals															
			Warranty	1.4.1	G	AE												
		07 55 00	SD-02 Shop Drawings															
			Roof Assembly	1.4.4	G	AE												
			Light bollards	2.7	G	AE												
			Trench Drain	2.6	G	AE												
			SD-03 Product Data															
			Geocomposite Drainage Mat	2.3														
			Setting Bed and Jointing Sand	2.4														
			Filter Fabric	2.5														
			Trench Drain	2.6														
			Trench Drain Grate	2.6.1														
			SD-07 Certificates															
			Material and Equipment	1.4.1														
			Qualifications	1.4.2														

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		07 62 13	SD-02 Shop Drawings																
			Sheet Metal	2.1.6															
			SD-03 Product Data																
			Contractor Quality Control	3.11															
			SD-04 Samples																
			Materials	2.1															
		07 81 00	SD-03 Product Data																
			Fireproofing Material	3.3	G	AE													
			SD-04 Samples																
			Spray-Applied Fireproofing	2.1	G	AE													
			SD-06 Test Reports																
			Fire Resistance Rating	1.2.2	G	AE													
			Field Tests	3.6	G	AE													
			Evaluation Reports	1.2.3	G	AE													
			SD-07 Certificates																
			Installer Qualifications	1.4.1	G	AE													
			Surface Preparation Report	3.1	G	AE													
			Manufacturer's Inspection Report	3.5.2	G	AE													
		07 84 00	SD-02 Shop Drawings																
			Firestopping System	2.1	G	AE													
			SD-03 Product Data																
			Firestopping Materials	2.2	G	AE													
			SD-06 Test Reports																
			Inspection	3.3	G	AE													
			SD-07 Certificates																
			Inspector Qualifications	1.5.2															

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		07 84 00	Firestopping Materials	2.2															
			Installer Qualifications	1.5.1	G	AE													
		07 92 00	SD-03 Product Data																
			Sealants	2.1	G	AE													
			Primers	2.2	G	AE													
			Bond Breakers	2.3	G	AE													
			Backstops	2.4	G	AE													
			Preconstruction Field-Adhesion	1.7.5	G	AE													
			Testing																
			Field Adhesion	3.1	G	AE													
			SD-07 Certificates																
			Indoor Air Quality For Interior	2.1.1	S														
			Sealants																
			Indoor Air Quality For Interior	2.1.3	S														
			Floor Joint Sealants																
			Indoor Air Quality For Interior	2.1.4	S														
			Acoustical Sealants																
		08 01 52	SD-01 Preconstruction Submittals																
			Window Repair Plan	3.1	G	AE													
			SD-02 Shop Drawings																
			Shop Drawings	1.5	G	AE													
			SD-03 Product Data																
			Hardware	2.1															
			Weatherstripping	3.2.9	G	AE													
			SD-04 Samples																
			Replacement and New Hardware	2.5	G	AE													

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		08 01 52	Weatherstripping	3.2.9															
			Glass and Glazing	2.4															
			SD-11 Closeout Submittals																
			LEED Documentation	1.3	G	AE													
		08 11 13.01	SD-02 Shop Drawings																
			Doors	2.1	G	AE													
			Doors	2.1	G	AE													
			Recycled Content for Steel Door	2.1	S														
			Product																
			Frames	2.5	G	AE													
			Frames	2.5	G	AE													
			Recycled Content for Steel Frame	2.5	S														
			Product																
			Accessories	2.3															
			Weatherstripping	2.7															
			SD-03 Product Data																
			Doors	2.1	G	AE													
			Frames	2.5	G	AE													
			Accessories	2.3															
			Weatherstripping	2.7															
			SD-04 Samples																
			Factory-applied enamel finish	2.9.4	G	AE													
		08 14 00	SD-02 Shop Drawings																
			Doors	2.1	G	RO													
			SD-03 Product Data																
			Doors	2.1	G	RO													

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		08 14 00	Accessories	2.3														
			Warranty	1.5														
			Sound Transmission Class	2.1.2	G	RO												
			Rating															
			Fire Resistance Rating	2.1.3	G	RO												
			SD-04 Samples															
			Doors	2.1														
			SD-06 Test Reports															
			Cycle-Slam	2.5														
			Hinge Loading Resistance	2.5														
			SD-07 Certificates															
			Certificates of Grade	1.3.1														
			Certified Sustainably Harvested	2.1.1	S													
			Stile and Rail Wood Doors															
			SD-11 Closeout Submittals															
			Warranty	1.5														
		08 31 00	SD-02 Shop Drawings															
			Access Doors And Panels	1.3	G	AE												
			SD-03 Product Data															
			Access Doors And Panels	1.3	G	AE												
			Hardware	1.3.2	G	AE												
			Accessories	2.2.8	G	AE												
			Recycled Content	2.1	S													
			SD-04 Samples															
			Finishes	2.5	G	AE												
			SD-06 Test Reports															

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		08 31 00	Fire-rating(s) of Assemblies	1.3.1	G	AE												
			Acoustical Ratings of Assemblies	1.3.1	G	AE												
		08 39 54	SD-02 Shop Drawings															
			Door Schedule	2.7.2	G	AE												
			Drawings	1.6.1	G	AE												
			Drawings	2.7.2	G	AE												
			Installation	3.1	G	AE												
			SD-03 Product Data															
			Product Data	1.4.4	G	AE												
			Doors	1.5	G	AE												
			Glass	2.1	G	AE												
			Fasteners	2.1	G	AE												
			Accessories	2.1	G	AE												
			Subframe	2.7.1	G	AE												
			Hardware	2.1	G	AE												
			Design Requirements	1.2.1	G	AE												
			Manufacturer's Field Service	3.3														
			SD-05 Design Data															
			Structural Calculations for	2.1	G	AE												
			Deflection															
			Design Analysis	1.4.4	G	RO												
			SD-06 Test Reports															
			Minimum Condensation	1.4.5	G	RO												
			Resistance Factor															
			SD-07 Certificates															
			Thermal Barrier	2.7.7														

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		08 39 54	SD-11 Closeout Submittals																
			Warranty	1.7	G	RO													
			LEED(TM) Documentation	1.8.1	S														
		08 51 13	SD-02 Shop Drawings																
			Windows	2.1	G	AE													
			Fabrication Drawings	1.8	G	AE													
			SD-03 Product Data																
			Windows	2.1	G	AE													
			Metal Infill Panels	2.4	G	AE													
			Recycled Content of Aluminum	2.1	S														
			Windows																
			Fasteners	2.2.2	G	RO													
			Window Performance	1.9	G	RO													
			Thermal-Barrier Windows	2.3	G	RO													
			Weatherstripping	2.1	G	RO													
			Accessories	2.2.5	G	RO													
			Adhesives	2.2.3															
			Thermal Performance	1.9.5	G	RO													
			SD-04 Samples																
			Finish Sample	1.4.3.1	G	AE													
			Window Sample	1.4.3.2	G	AE													
			Metal Infill Panels	2.4	G	AE													
			Mock-Ups	1.4.3.3	G	RO													
			SD-05 Design Data																
			Structural Calculations for	2.1	G	RO													
			Deflection																

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		08 51 13	Design Analysis	1.4.4	G	RO													
			SD-06 Test Reports																
			Minimum Condensation	1.4.5	G	RO													
			Resistance Factor																
			U-Factor	1.9.5	G	RO													
			Air Leakage	1.11	G	RO													
			Water Penetration	1.9.4	G	RO													
			Resistance to Forced Entry	1.4.5	G	RO													
			SD-10 Operation and Maintenance																
			Data																
			Windows	2.1	G	RO													
			SD-11 Closeout Submittals																
			LEED(TM) Documentation	1.6.1	S														
			Recycled Content	2.1															
		08 71 00	SD-02 Shop Drawings																
			Manufacturer's Detail Drawings	1.3	G	AE													
			Verification of Existing Conditions	1.3	G	AE													
			Hardware Schedule	1.5	G	RO													
			Keying System	2.3.7	G	RO													
			SD-03 Product Data																
			Hardware Items	2.3	G	AE													
			SD-08 Manufacturer’s Instructions																
			Installation	3.1															
			SD-10 Operation and Maintenance																
			Data																
			Hardware Schedule	1.5	G	RO													

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		08 71 00	SD-11 Closeout Submittals																
			Key Bitting	1.6.1															
		08 81 00	SD-03 Product Data																
			Insulating Glass	2.2	G	AE													
			Glazing Accessories	1.3	G	AE													
			Sealants	2.3.2.1	G	AE													
			SD-04 Samples																
			Insulating Glass	2.2	G	AE													
			Laminated uninsulated glass	1.4	G	AE													
			Glazing Compound	2.3.1	G	RO													
			Tape	2.3.4	G	RO													
			Sealing Tapes	2.3.4	G	RO													
			SD-07 Certificates																
			Insulating Glass	2.2	G	RO													
			SD-08 Manufacturer’s Instructions																
			Setting and Sealing Materials	2.3															
			Glass Setting	3.2															
			SD-11 Closeout Submittals																
			Insulated Glass Units	1.7.1															
		08 91 00	SD-02 Shop Drawings																
			Wall louvers	1.4	G	AE													
			Wall louvers	1.5	G	AE													
			SD-03 Product Data																
			Metal Wall Louvers	2.2	G	AE													
			SD-04 Samples																
			Wall louvers	1.4	G	RO													

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		08 91 00	Wall louvers	1.5	G	RO													
		09 01 90.50	SD-03 Product Data																
			Work Plan	1.2	G	AE													
			Materials	1.2	G	AE													
			Qualifications	1.4.4	G	RO													
			SD-04 Samples																
			Mock-Ups	1.4.5	G	AE													
			SD-07 Certificates																
			Work Plan	1.2	G	AE													
		09 22 00	SD-02 Shop Drawings																
			Metal Support Systems	2.1	G	AE													
			SD-03 Product Data																
			Metal Support Systems	2.1															
			Recycled Content for Metal	2.1	S														
			Support Systems																
		09 22 36	SD-03 Product Data																
			Lath	2.1	G	AE													
			Recycled Content for Metal Lath	2.1	S														
			Accessories	2.1.2	G	AE													
			Access Panels	2.2	G	AE													
		09 23 00	SD-01 Preconstruction Submittals																
			Work Plan	1.3.4	G	AE													
			Qualifications	1.3.1	G	RO													
			SD-02 Shop Drawings																
			Photographic Documentation	1.3.6															
			SD-03 Product Data																

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		09 23 00	Base Coat Plaster	2.8.1															
			Plaster Finish Coat	2.8.2															
			Structural Clay Tile	2.11															
			Gypsum Neat Plaster	2.2	G	AE													
			Gypsum Gauging Plaster	2.3	G	AE													
			Lime Plaster Materials	2.4	G	AE													
			Aggregates	2.5	G	AE													
			Fibers	2.6	G	AE													
			Scagliola Materials	2.12	G	AE													
			SD-04 Samples																
			Mock-ups	1.3.5	G	AE													
			Structural Clay (Terra Cotta) Tile	2.11	G	AE													
			SD-08 Manufacturer’s Instructions																
			Ready-Mix Lime Plaster	2.4	G	AE													
			Bonding Agent	2.10	G	AE													
		09 29 00	SD-03 Product Data																
			Cementitious Backer Units	2.1.2															
			Accessories	2.1.8															
			Gypsum Board	2.1.1															
			Recycled Content for Gypsum	2.1.1	S														
			Board																
			Recycled Content for Paper	2.1.1	S														
			Facing and Gypsum Cores																
			VOC Content of Joint Compound	2.1.3	S														
			SD-07 Certificates																
			Asbestos Free Materials	2.1	G	RO													

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		09 29 00	Indoor Air Quality for Gypsum	2.1.1	S													
			Board															
			Indoor Air Quality for Non-aerosol	2.1.5	S													
			Adhesives															
			Indoor Air Quality for Aerosol	2.1.5	S													
			Adhesives															
			SD-08 Manufacturer's Instructions															
			Safety Data Sheets	2.1														
			SD-10 Operation and Maintenance															
			Data															
			Manufacturer Maintenance	2.1														
			Instructions															
		09 30 10	SD-02 Shop Drawings															
			Detail Drawings	3.2	G	RO												
			SD-03 Product Data															
			Porcelain Tile	2.1.1	G	RO												
			Recycled Content for Porcelain	2.1.1	S													
			Tile															
			Glazed Wall Tile	2.1.2	G	RO												
			Recycled Content for Glazed Wall	2.1.2	S													
			Tile															
			Setting-Bed	2.2	G	RO												
			Mortar and Grout	2.4	G	RO												
			SD-04 Samples															
			Tile	2.1	G	RO												
			Accessories	2.1	G	RO												

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		09 30 10	Accessories	2.1.3	G	RO												
			Transition Strips	2.1	G	RO												
			Transition Strips	2.6	G	RO												
			Grout	2.4.3	G	RO												
			SD-07 Certificates															
			Indoor Air Quality for Adhesives	2.4	S													
			Indoor Air Quality for Sealants	2.4.5	S													
			SD-08 Manufacturer’s Instructions															
			Maintenance Instructions	3.6														
			SD-10 Operation and Maintenance															
			Data															
			Installation	3.2	G	RO												
		09 30 33	SD-01 Preconstruction Submittals															
			Quality Control Plan	1.5.1	G	AE												
			Project Training Program	1.3.1	G	RO												
			Qualifications	1.5.2	G	RO												
			SD-02 Shop Drawings															
			Photographic Documentation	1.5.3	G	AE												
			SD-03 Product Data															
			Qualifications	1.5.2														
			Cleaning and Restoration	1.5.4	G	AE												
			Methods															
			Cleaning Materials	2.1	G	AE												
			Setting-Bed	2.4	G	AE												
			Replacement Marble	2.2.3.1	G	AE												
			Repair Materials	2.2	G	AE												

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		09 30 33	SD-04 Samples																
			Replacement Marble	2.2.3.1	G	AE													
			Repair Materials	2.2	G	AE													
			Mock-ups	1.5.5.1	G	AE													
			SD-07 Certificates																
			Repair Materials	2.2															
		09 51 00	SD-02 Shop Drawings																
			Approved Detail Drawings	2.1	G	RO													
			SD-03 Product Data																
			Acoustical Ceiling Systems	1.9	G	RO													
			Recycled Content for Type IV	2.2.1.1	S														
			Ceiling Tiles																
			Recycled Content for Type XII	2.2.2.1	S														
			Ceiling Tiles																
			Recycled Content for Suspension	2.3	S														
			Systems																
			SD-04 Samples																
			Acoustical Units	2.2	G	RO													
			Acoustical Ceiling Tiles	2.1	G	RO													
			SD-06 Test Reports																
			Ceiling Attenuation Class and	2.1.1	G	RO													
			Test																
			SD-07 Certificates																
			Indoor Air Quality for Type IV	2.2.1.1	S														
			Ceiling Tiles																
			Indoor Air Quality for Adhesives	2.6	S														

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		09 51 00	Indoor Air Quality for Sealants	2.9	S														
		09 62 38	SD-03 Product Data																
			Recycled content for	2.1.1.1	S														
			Static-Dissipative Vinyl Tile																
			Accessories	2.5	G	RO													
			Adhesives	2.3	G	RO													
			Warranty	1.9															
			SD-04 Samples																
			Static-Control Resilient Flooring	2.1	G	RO													
			Moldings	2.4	G	RO													
			Special Treatment Materials	1.3.1.3	G	RO													
			Accessories	2.5	G	RO													
			SD-06 Test Reports																
			Fire Resistance	2.8															
			Moisture, Alkalinity and Bond	3.2															
			Testing	3.7															
			SD-07 Certificates																
			Indoor Air Quality for	2.1.1.1	S														
			Static-Dissipative Vinyl Tile																
			Indoor Air Quality for Adhesives	2.3	S														
			Qualifications of Applicator	1.6															
			SD-08 Manufacturer’s Instructions																
			Static-Control Resilient Flooring	2.1	G	RO													
			Accessories	2.5	G	RO													
			SD-10 Operation and Maintenance																
			Data																

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		09 62 38	Static-Control Resilient Flooring	2.1	G	RO												
			Accessories	2.5	G	RO												
		09 64 29	SD-02 Shop Drawings															
			Strip Flooring	2.1	G	RO												
			SD-03 Product Data															
			Strip Flooring	2.1														
			Recycled Content for Wood Strip and Plank Flooring	2.1.1	S													
			Adhesives	2.3														
			Installation	3.2														
			SD-04 Samples															
			Strip And Plank Flooring	2.1.1														
			SD-07 Certificates															
			Certified Sustainably Harvested Wood Strip and Plank Flooring	2.1.1	S													
			Indoor Air Quality for Wood Strip and Plank Flooring	2.1.1	S													
		09 65 00	SD-02 Shop Drawings															
			Resilient Flooring and Accessories	2.7	G	RO												
			SD-03 Product Data															
			Resilient Flooring and Accessories	2.7	G	RO												
			Adhesives	2.4														
			SD-04 Samples															

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		09 65 00	Resilient Flooring and	2.7	G	RO													
			Accessories																
			SD-06 Test Reports																
			Moisture, Alkalinity and Bond	3.3	G	RO													
			Tests																
			SD-07 Certificates																
			Indoor Air Quality for Linoleum	2.1	S														
			Indoor Air Quality for Wall Base	2.2	S														
			Indoor Air Quality for Adhesives	2.4	S														
			SD-08 Manufacturer’s Instructions																
			Surface Preparation	3.2	G	RO													
			Installation	3.1	G	RO													
			SD-10 Operation and Maintenance																
			Data																
			Resilient Flooring and	2.7	G	RO													
			Accessories																
		09 67 23.13	SD-02 Shop Drawings																
			Installation Drawings	2.1	G	RO													
			Fabrication Drawings	2.1	G	RO													
			SD-03 Product Data																
			Manufacturer's Catalog Data	1.2.2	G	RO													
			SD-04 Samples																
			Hardboard Mounted Epoxy	1.5.3	G	RO													
			Flooring																
			Floor Topping	3.1.4	G	RO													
			Mockups	1.5.1	G	RO													

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		09 67 23.13	SD-05 Design Data																
			Design Mix Data	1.2.3	G	RO													
			SD-07 Certificates																
			Listing of Product Installations	1.5.2															
			Referenced Standards	1.5															
			Certificates																
			SD-11 Closeout Submittals																
			Warranty	1.6	G	RO													
		09 68 00	SD-02 Shop Drawings																
			Installation Drawings	3.4	G	RO													
			SD-03 Product Data																
			Carpet	2.1	G	RO													
			Carpet Cushion	2.1	G	RO													
			Recycled Content for Carpeting	2.1.1	S														
			Moldings	2.4	G	RO													
			Indoor Air Quality for Aerosol	2.3	S														
			Adhesives																
			Indoor Air Quality for Non-Aerosol	2.3	S														
			Adhesives																
			Indoor Air Quality for Concrete	2.3	S														
			Primer																
			SD-04 Samples																
			Carpet	2.1	G	RO													
			Moldings	2.4	G	RO													
			Carpet Cushion	2.1	G	RO													
			SD-06 Test Reports																

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		09 68 00	Moisture and Alkalinity Tests	3.2	G	RO													
			SD-07 Certificates																
			Indoor Air Quality for Carpet	2.1.1	S														
			Indoor Air Quality for Carpet	2.1.2	S														
			SD-08 Manufacturer’s Instructions																
			Surface Preparation	3.1															
			SD-10 Operation and Maintenance																
			Data																
			Cleaning and Protection	3.5															
			SD-11 Closeout Submittals																
			Warranty	1.6															
		09 84 20	SD-02 Shop Drawings																
			Approved Detail Drawings	2.2	G	RO													
			SD-03 Product Data																
			Installation	3.2															
			Acoustical Wall Panels	2.2	G	RO													
			Recycled Content for Fabric	2.1.1.1	S														
			Panels																
			SD-04 Samples																
			Acoustical Wall Panels	2.2	G	RO													
			SD-07 Certificates																
			Acoustical Wall Panels	2.2															
			SD-11 Closeout Submittals																
			Warranty	1.4															
		09 90 00	SD-02 Shop Drawings																
			Piping Identification	3.11	G	RO													

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		09 90 00	SD-03 Product Data																
			Coating	2.1	G	AE													
			SD-04 Samples																
			Color and Finish	1.11	G	AE													
			Mock-ups for replication of	1.5.2	G	RO													
			existing historical finishes to inclue:																
			Stair Railings, Ballroom Columns,																
			Stage Apron, Cornices and Ceiling																
			Trims, and Typical Wall Coatings																
			SD-07 Certificates																
			Applicator's Qualifications	1.4	G	RO													
			Qualification Testing	1.5.1.2	G	RO													
			Indoor Air Quality for Paints and	2.1	S														
			Primers																
			Indoor Air Quality for	2.1	S														
			Consolidated Latex Paints																
			SD-08 Manufacturer’s Instructions																
			Application Instructions	3.3.1															
			Mixing	3.7.2															
			Manufacturer's Safety Data	1.8.2	G	RO													
			Sheets																
			SD-10 Operation and Maintenance																
			Data																
			Coatings	2.1	G	RO													
		09 91 12	SD-02 Shop Drawings																
			Work Plan	1.2	G	AE													

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		09 91 12	SD-03 Product Data																
			Coating	2.1	G	AE													
			SD-04 Samples																
			Color	1.7	G	AE													
			SD-07 Certificates																
			Applicator's Qualifications	1.4	G	AE													
			Qualification Testing	1.5	G	AE													
			SD-08 Manufacturer’s Instructions																
			Mixing and Application	2.1															
			Manufacturer's Safety Data	1.8.2															
			Sheets																
			SD-10 Operation and Maintenance																
			Data																
			Coatings	2.1	G	AE													
		10 11 00	SD-03 Product Data																
			Visual Display Board	1.2	G	AE													
			Tackable Surface	2.1.2	G	AE													
			SD-04 Samples																
			Aluminum	2.1.3	G	RO													
			Porcelain Enamel	2.1.1	G	AE													
			Materials	2.1	G	RO													
			SD-07 Certificates																
			Indoor air quality for	2.2	S														
			markerboards																
			Indoor air quality for tackboards	2.3	S														
		10 14 00.20	SD-02 Shop Drawings																

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		10 14 00.20	Detail Drawings	1.4.2	G	AE												
			SD-03 Product Data															
			Installation	3.1	G	RO												
			Warranty	1.6	G	RO												
			SD-04 Samples															
			Interior Signage	1.4.1	G	AE												
			Software	1.3	G	RO												
			SD-10 Operation and Maintenance															
			Data															
			Approved Manufacturer's	3.1	G	RO												
			Instructions															
			Protection and Cleaning	3.1.2	G	RO												
		10 21 13	SD-02 Shop Drawings															
			Fabrication Drawings	2.1														
			Installation Drawings	3.2	G	RO												
			SD-03 Product Data															
			Cleaning and Maintenance	2.1														
			Instructions															
			Colors And Finishes	2.8														
			Galvanized Steel Sheet	2.2.1														
			Sound-Deadening Cores	2.2.2														
			Anchoring Devices and Fasteners	2.2.3														
			Hardware and Fittings	2.2.5														
			Brackets	2.2.4														
			Door Hardware	2.2.6														
			Pilaster Shoes	2.6														

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		10 21 13	Finishes	2.2.5.2	G	RO												
			SD-04 Samples															
			Colors and Finishes	2.8	G	RO												
			Hardware and Fittings	2.2.5														
			Anchoring Devices and Fasteners	2.2.3														
			SD-07 Certificates															
			Warranty	1.6														
			Indoor air quality for solid	2.3	S													
			polyethylene (HDPE), partitions															
			and screens															
		10 22 13	SD-02 Shop Drawings															
			Wire Mesh Partitions	1.4														
			SD-03 Product Data															
			Wire Mesh Partitions	1.4														
		10 22 19	SD-02 Shop Drawings															
			Installation	3.3	G	AE												
			SD-03 Product Data															
			Warranty	1.7	G	RO												
			Partition System	2.2	G	RO												
			Partition System	2.2	G	RO												
			SD-04 Samples															
			Partition System Samples	2.4	G	RO												
			SD-07 Certificates															
			Burning Characteristics	2.1.1	G	RO												
			Acoustical Performance	2.1.2	G	RO												
			Structural Performance	2.1.3	G	RO												

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		10 22 19	Indoor air quality for aerosol	2.3.1	S													
			adhesives															
			SD-10 Operation and Maintenance															
			Data															
			Maintenance Manuals	3.5	G RO													
		10 26 00	SD-02 Shop Drawings															
			Corner Guards	2.2	G AE													
			Wall Guards (Bumper Guards)	2.3	G AE													
			Wall Covering/Panels	1.3.1.1	G AE													
			SD-03 Product Data															
			Corner Guards	2.2	G RO													
			Wall Guards (Bumper Guards)	2.3														
			Wall Covering/Panels	1.3.1.1	G RO													
			Recycled content for steel	2.2.2	S													
			component of corner guards															
			SD-04 Samples															
			Finish	2.5	G AE													
			SD-06 Test Reports															
			Corner Guards	2.2														
			Wall Guards (Bumper Guards)	2.3														
			Wall Covering/Panels	1.3.1.1														
			SD-07 Certificates															
			Corner Guards	2.2														
			Wall Guards (Bumper Guards)	2.3														
			Indoor air quality for adhesives	2.6	S													
		10 28 13	SD-03 Product Data															

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		10 28 13	Finishes	2.1.2	G	AE													
			Accessory Items	2.2	G	AE													
			Recycled content for stainless	2.1	S														
			steel toilet accessories																
			Tested Sound Power Level by	2.2.10	G	AE													
			decibels for Electric Hand Dryer																
			SD-04 Samples																
			Finishes	2.1.2	G	RO													
			Accessory Items	2.2															
			SD-07 Certificates																
			Accessory Items	2.2															
			SD-10 Operation and Maintenance																
			Data																
			Electric Hand Dryer	2.2.10	G	RO													
		10 44 16	SD-01 Preconstruction Submittals																
			Manufacturer's Data	2.1.1	G	AE													
			SD-02 Shop Drawings																
			Fire Extinguishers	2.1.1	G	AE													
			Accessories	Part 2	G	AE													
			Cabinets	2.2.1	G	AE													
			Wall Brackets	2.2.2	G	AE													
			SD-03 Product Data																
			Fire Extinguishers	2.1.1	G	AE													
			Accessories	Part 2	G	AE													
			Fire Extinguisher Cabinets	Part 2	G	AE													
			Fire Extinguisher Wall Brackets	Part 2	G	AE													

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		10 44 16	Fire Extinguisher Wall Brackets	2.2.2	G	AE												
			Replacement Parts List	3.2.1	G	AE												
			SD-04 Samples															
			Fire Extinguishers	2.1.1	G	AE												
			Cabinets	2.2.1	G	AE												
			Fire Extinguisher Wall Brackets	Part 2	G	AE												
			Fire Extinguisher Wall Brackets	2.2.2	G	AE												
			Accessories	Part 2	G	AE												
			SD-07 Certificates															
			Fire Extinguishers	2.1.1	G	AE												
			Manufacturer's Warranty with	2.1.1	G	AE												
			Inspection Tag															
		10 56 13	SD-01 Preconstruction Submittals															
			Shelving Units	2.1	G	AE												
			SD-02 Shop Drawings															
			Dimensioned Rail Layouts with	1.4	G	AE												
			Field Dimensions															
			Dimensioned Carriage Layouts	1.4	G	AE												
			Details of Shelving Units	1.4	G	AE												
			Installation Sequencing and	1.6	G	AE												
			Scheduling															
			SD-03 Product Data															
			Shelving Units	2.1	G	RO												
			Accessories	1.4	G	RO												
			Installation instructions	3.2	G	RO												
			SD-04 Samples															

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		10 56 13	Finishes	2.2	G	AE													
			SD-06 Test Reports																
			Shelving Units	2.1	G	RO													
			Finish	2.2	G	RO													
		12 24 13	SD-02 Shop Drawings																
			Installation	3.3	G	AE													
			SD-03 Product Data																
			Window Shades	2.1	G	AE													
			Recycled Content for various	2.1	S														
			fiber components																
			SD-04 Samples																
			Window Shades	2.1	G	AE													
			SD-06 Test Reports																
			Window Shades	2.1															
			SD-07 Certificates																
			Indoor Air Quality for roller	2.1	S														
			window shades																
			SD-08 Manufacturer's Instructions																
			Window Shades	2.1															
			SD-10 Operation and Maintenance																
			Data																
			Window Shades	2.1															
			SD-11 Closeout Submittals																
			Warranty	1.7	G	RO													
		12 36 00	SD-02 Shop Drawings																
			Fabrication	2.3	G	AE													

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		12 36 00	Installation Drawings	3.1	G	AE													
			SD-03 Product Data																
			Plywood	2.4	G	RO													
			Hardwood	2.4	G	RO													
			Solid Acrylic Resin	2.3.1.1	G	RO													
			Solid Quartz/Polymer Resin	2.3.1.1	G	RO													
			Adhesives	2.4	G	RO													
			Filler Material	2.4	G	RO													
			Particle Board	2.4	G	RO													
			Recycled Content for	2.4	S														
			Particleboard																
			Turpentine	2.4	G	RO													
			Varnish	2.4	G	RO													
			Fasteners	2.4	G	RO													
			Joint Sealants	2.5.2	G	RO													
			Softwoods	2.4	G	RO													
			Plastic Laminate	2.4	G	RO													
			Indoor Air Quality for Laminate	2.4	S														
			and Wood Member Adhesives																
			Indoor Air Quality for Mounting	2.5.1	S														
			and Stone Adhesives																
			Indoor Air Quality for Joint	2.5.2	S														
			Sealants																
			SD-04 Samples																
			Countertop	2.3.1	G	RO													
			Solid Acrylic Resin	2.3.1.1	G	RO													

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(a)	(b)	(c)	(d)	(e)	(f)		(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		12 36 00	Solid Quartz/Polymer Resin	2.3.1.1	G	RO												
			Backsplash	2.3.1	G	RO												
			SD-07 Certificates															
			Certified Sustainably Harvested	1.3.1	S													
			Wood															
			Indoor Air Quality for Countertop	2.2	S													
			Products															
			Indoor Air Quality for	2.4	S													
			Particleboard															
			SD-08 Manufacturer’s Instructions															
			Manufacturer's Instructions	2.2														
		12 48 13	SD-02 Shop Drawings															
			Installation Drawings	3.2	G	AE												
			Detail Drawings	3.2	G	AE												
			SD-03 Product Data															
			Entrance Floor Mats and Frames	2.1.1	G	RO												
			Adhesives and Concrete Primers	2.1.2	G	RO												
			SD-04 Samples															
			Entrance Floor Mats and Frames	2.1.1	G	AE												
			SD-08 Manufacturer’s Instructions															
			Manufacturer's Instructions	3.2														
			SD-10 Operation and Maintenance															
			Data															
			Protection, Maintenance, and	3.2														
			Repair Information															
		13 21 00	SD-02 Shop Drawings															

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		13 21 00	Environmental Rooms	2.1.1	G	AE												
			Piping Diagrams and Wiring	2.4	G	AE												
			Diagrams															
			SD-03 Product Data															
			Environmental Rooms	2.1.1	G	AE												
			Environmental Equipment	2.6	G	AE												
			Label For Refrigeration	2.8	S													
			Equipment															
			SD-04 Samples															
			Panels	2.2	G	AE												
			Flooring	2.3	G	AE												
			Flooring	2.3	G	AE												
			SD-06 Test Reports															
			Tests	3.3	G	AE												
			Flame Spread Index	2.2	G	AE												
			Smoke-Developed Index	2.2	G	AE												
			SD-08 Manufacturer’s Instructions															
			Environmental Rooms	2.1.1														
			Environmental Equipment	2.6														
			SD-10 Operation and Maintenance															
			Data															
			Environmental Rooms	2.1.1	G	AE												
			Environmental Equipment	2.6	G	AE												
			SD-11 Closeout Submittals															
			Operating Instructions and	3.5	G	AE												
			training															

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		13 21 48	SD-03 Product Data															
			Angle Brackets	2.2														
			Bond Breaker Material	2.3														
			Masonry Wall Sway Braces	2.4														
			Perimeter Isolation Board	2.5														
			Perimeter Caulking Compound	2.6														
			Ceiling Isolation Hangers	2.7														
			Ductwork and Ceiling Services	2.8														
			Hanger															
			Outlet and Junction Box Backing	2.9														
			Material															
			Sound Barrier Lagging Material	2.10														
			Neoprene Sponge Material	2.11														
		14 24 23	SD-02 Shop Drawings															
			Elevator	2.1	G	RO												
			Elevator Components	1.3.1	G	RO												
			Elevator Machine	1.2.1	G	RO												
			Elevator Controller	1.2.1	G	RO												
			Wiring Diagrams	1.3.4	G	RO												
			Interior Cab Finishes Detail	1.2.1	G	AE												
			Drawings															
			Commercial Wheelchair Lift	1.2.1	G	RO												
			System & Components															
			SD-04 Samples															

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		14 24 23	SST Finish Samples for	2.1.2.1	G	AE													
			Pre-Engineered Interior Finish																
			System (4x4)																
			SD-03 Product Data																
			Elevator	2.1	G	RO													
			Elevator Components	1.3.1	G	RO													
			Data Sheets	1.2.4	G	RO													
			Elevator Microprocessor	2.5.2	G	RO													
			Controller																
			Commercial Wheelchair Lift	1.2.1	G	RO													
			Commercial Wheelchair Lift	2.11.1	G	RO													
			SD-05 Design Data																
			Emergency Power, Systems, and	1.2.8															
			Operations																
			Heat Loads	1.2.5.2															
			Reaction Loads	1.2.5.1															
			SD-07 Certificates																
			Price Lists	1.3.2	G	RO													
			Warranty	1.4															
			Endorsement Letter	1.3.1.1															
			Welders' Qualifications	1.2.6															
			Elevator Controller Certification	2.5.2.3	G	RO													
			SD-10 Operation and Maintenance																
			Data																
			Elevator	2.1	G	RO													

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		14 24 23	Maintenance Control Program	1.2.7	G	RO												
			(MCP)															
			Software and Documentation	2.5.2.2	G	RO												
			Commercial Wheelchair Lift, Data	2.11	G	RO												
			Package 4															
		21 12 00	SD-02 Shop Drawings															
			Standpipe system	1.3.4	G	AE												
			SD-03 Product Data															
			Pipe and fittings	2.1.1	G	AE												
			Mechanical couplings	2.1.1	G	AE												
			Pipe hangers and supports	2.1.2	G	AE												
			Valves	2.1.3	G	AE												
			SD-06 Test Reports															
			Preliminary tests	3.7.1	G	AE												
			Acceptance tests	3.7.2	G	AE												
			SD-07 Certificates															
			Qualifications of installer	1.5.1	G	AE												
			SD-11 Closeout Submittals															
			System as-built drawings	1.5.2	G	AE												
		21 13 13.00 10	SD-02 Shop Drawings															
			Shop Drawings	1.4.3	G	AE												
			As-Built Drawings	3.9														
			SD-03 Product Data															
			Finish Samples for Concealed	2.10.1	G	AE												
			Sprinkler Cover Plates															

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		21 13 13.00 10	Fire Protection Related	1.4.1															
			Submittals																
			Materials and Equipment	2.3	G	AE													
			Spare Parts	1.6															
			Preliminary Tests	3.8	G	AE													
			Final Acceptance Test	3.9	G	AE													
			Onsite Training	3.10	G	AE													
			Fire Protection Specialist	1.4.1	G	AE													
			Sprinkler System Installer	1.4.2	G	AE													
			SD-05 Design Data																
			Sway Bracing	1.4.3	G	AE													
			Hydraulic Calculations	1.2.1.3	G	AE													
			SD-06 Test Reports																
			Preliminary Test Report	3.8															
			Final Acceptance Test Report	3.9															
			SD-07 Certificates																
			Inspection by Fire Protection	3.3															
			Specialist																
			SD-10 Operation and Maintenance																
			Data																
			Operating and Maintenance	3.10	G	AE													
			Manuals																
		21 30 00	SD-01 Preconstruction Submittals																
			Fire Pump Installation Related	1.3															
			Submittals																
			Fire Protection Specialist	1.7.1	G	AE													

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		21 30 00	SD-02 Shop Drawings																
			Installation Drawings	3.3.1	G	AE													
			As-Built Drawings	3.11.2	G	AE													
			Piping Layout	3.3.2	G	AE													
			Pump House	2.2	G	AE													
			SD-03 Product Data																
			Catalog Data	2.1	G	AE													
			Spare Parts	1.6															
			Preliminary Tests	3.8.2															
			Field Tests	3.8	G	AE													
			Manufacturer's Representative	1.7.6	G	AE													
			Field Training	3.11.1	G	AE													
			Army Final Acceptance Test	3.8.3															
			SD-06 Test Reports																
			Preliminary Tests	3.8.2															
			Army Final Acceptance Test	3.8.3															
			SD-07 Certificates																
			Fire Protection Specialist	1.7.1															
			Qualifications of Welders	1.7.2															
			Qualifications of Installer	1.7.3															
			Preliminary Test Certification	1.7.4															
			Final Test Certification	1.7.5															
			SD-10 Operation and Maintenance																
			Data																
			Operating and Maintenance	3.11.1	G	AE													
			Instructions																

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		21 30 00	Flow Meter	2.13															
		22 00 00	SD-02 Shop Drawings																
			Plumbing System	3.9.1	G	AE													
			SD-03 Product Data																
			Fixtures	2.4															
			Flush Valve Water Closets	2.4.2															
			Flush Valve Urinals	2.4.3															
			Wall Hung Lavatories	2.4.5															
			Countertop Lavatories	2.4.6															
			Kitchen Sinks	2.4.7															
			Service Sinks	3.3.3															
			Drinking-Water Coolers	2.4.8	G	RO													
			Energy Star Label for Electric	2.4.8	S														
			Water Cooler																
			Energy Star Label for Wheelchair	2.4.9	S														
			Electric Water Cooler																
			Water Heaters	2.7	G	RO													
			Pumps	2.8	G	RO													
			Backflow Prevention Assemblies	3.9.1.1	G	RO													
			Welding	1.5.1															
			Vibration-Absorbing Features	3.4	G	RO													
			Plumbing System	3.9.1															
			SD-06 Test Reports																
			Tests, Flushing and Disinfection	3.9															
			Test of Backflow Prevention	3.9.1.1	G	RO													
			Assemblies																

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		22 00 00	SD-07 Certificates															
			Materials and Equipment	1.3														
			Bolts	2.1.1														
			SD-10 Operation and Maintenance															
			Data															
			Plumbing System	3.9.1	G	RO												
		22 07 19.00 40	SD-02 Shop Drawings															
			Installation Drawings	3.1	G	RO												
			SD-03 Product Data															
			Adhesives	2.3	G	RO												
			Coatings	2.3	G	RO												
			Insulating Cement	2.3	G	RO												
			Insulation Materials	2.3	G	RO												
			Jacketing	2.3	G	RO												
			Tape	2.3	G	RO												
			SD-08 Manufacturer’s Instructions															
			Installation Manual	3.1	G	RO												
			SD-11 Closeout Submittals															
			Record Drawings	3.4														
			Adhesives	2.3	S													
			Coatings	2.3	S													
			Insulation Materials	2.3	S													
			Recycled Materials	1.3.1	S													
		23 00 00	SD-02 Shop Drawings															
			Detail Drawings	1.4.4	G	AE												
			SD-03 Product Data															

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		23 00 00	Metallic Flexible Duct	2.8.1.1															
			Insulated Nonmetallic Flexible	2.8.1.2															
			Duct Runouts																
			Duct Connectors	2.8.1.2															
			Duct Access Doors	2.8.2	G	AE													
			Fire Dampers	2.8.3															
			Manual Balancing Dampers	2.8.4	G	AE													
			Sound Attenuation Equipment	2.8.9															
			Acoustical Duct Liner	2.8.9.3															
			Diffusers	2.8.10.1															
			Registers and Grilles	2.8.10.2															
			Louvers	2.8.11															
			Air Vents, Penthouses, and	2.8.12															
			Goosenecks																
			Centrifugal Fans	2.9.1.1															
			In-Line Centrifugal Fans	2.9.1.2															
			Ceiling Exhaust Fans	2.9.1.3															
			Energy Star label for ceiling	2.9.1.3	S														
			exhaust fan product																
			Air Handling Units	2.9.3.4	G	AE													
			Fan-Coil Units	2.10.1	G	AE													
			Variable Volume, Single Duct	2.10.2.1	G	AE													
			Terminal Units																
			Reheat Units	2.10.2.2	G	AE													
			Hydronic Modular Panels	2.18.1	G	AE													
			Test Procedures	1.4.5															

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		23 00 00	Diagrams	1.2.1.2	G	AE												
			Indoor Air Quality for Duct	2.8.1	S													
			Sealants															
			SD-06 Test Reports															
			Performance Tests	3.13.2	G	AE												
			Damper Acceptance Test	3.9	G	AE												
			SD-07 Certificates															
			Bolts	1.4.1														
			Ozone Depleting Substances	1.4.3														
			Technician Certification															
			SD-08 Manufacturer’s Instructions															
			Manufacturer's Installation	3.2														
			Instructions															
			Operation and Maintenance	3.13.2														
			Training															
			SD-10 Operation and Maintenance															
			Data															
			Operation and Maintenance	3.13.1	G	AE												
			Manuals															
			Fire Dampers	2.8.3	G	AE												
			Manual Balancing Dampers	2.8.4	G	AE												
			Centrifugal Fans	2.9.1.1	G	AE												
			In-Line Centrifugal Fans	2.9.1.2	G	AE												
			Ceiling Exhaust Fans	2.9.1.3	G	AE												
			Air Handling Units	2.9.3.4	G	AE												
			Room Fan-Coil Units	2.10.1	G	AE												

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		23 00 00	Variable Volume, Single Duct	2.10.2.1	G	AE												
			Terminal Units															
			Reheat Units	2.10.2.2	G	AE												
			Hydronic Modular Panels	2.18.1	G	AE												
			SD-11 Closeout Submittals															
			Indoor Air Quality During	3.11	S													
			Construction															
		23 05 15	SD-02 Shop Drawings															
			Coordination Drawings	1.2	G	AE												
			Installation Drawings	3.1	G	AE												
			SD-03 Product Data															
			Supporting Elements	2.1	G	AE												
		23 05 48.00 40	SD-02 Shop Drawings															
			Installation Drawings	1.2	G	AE												
			Outline Drawings	1.2	G	AE												
			SD-03 Product Data															
			Equipment and Performance	1.2	G	AE												
			Data															
			Isolators	2.2.11	G	AE												
			SD-06 Test Reports															
			Type of Isolator	2.4	G	AE												
			Type of Base	2.4	G	AE												
			Allowable Deflection	2.4	G	AE												
			Measured Deflection	2.4	G	AE												
		23 05 93	SD-01 Preconstruction Submittals															
			Records of Existing Conditions	1.3.3	G	AE												

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		23 05 93	TAB Firm	1.5.4.1	G	AE												
			TAB Team Assistants	1.2	G	AE												
			TAB Team Engineer	1.2	G	AE												
			TAB Specialist	1.5.4.2	G	AE												
			TAB Team Field Leader	1.2	G	AE												
			SD-02 Shop Drawings															
			TAB Schematic Drawings and	1.3.3	G	AE												
			Report Forms															
			SD-03 Product Data															
			Equipment and Performance	1.3	G	AE												
			Data															
			TAB Related HVAC Submittals	1.5.4.4	G	AE												
			TAB Procedures	1.5.2	G	AE												
			Calibration	1.5.2	G	AE												
			Systems Readiness Check	1.3.3	G	AE												
			TAB Execution	1.5.5	G	AE												
			TAB Verification	1.5.5.3	G	AE												
			SD-06 Test Reports															
			Completed Pre-Final DALT	3.3.5	G	AE												
			Report															
			Certified Final DALT Report	3.3.8	G	AE												
			TAB Design Review Report	1.7.2.1	G	AE												
			TAB Report for Season 1	1.5.6.2	G	AE												
			TAB Report for Season 2	1.5.6.2	G	AE												
			SD-07 Certificates															

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		23 05 93	Independent TAB Agency and	1.5.1	G	AE												
			Personnel Qualifications															
			DALT and TAB Submittal and	1.7.2	G	AE												
			Work Schedule															
			TAB Pre-Field Engineering	1.7.2.3	G	AE												
			Report															
			TAB Firm	1.5.4.1	G	AE												
			Design Review Report	1.3.3	G	AE												
			Pre-field DALT Preliminary	1.7.2.2	G	AE												
			Notification															
			Advanced Notice for Season 1	1.7.2	G	AE												
			TAB Field Work															
			Prerequisite HVAC Work Check	1.7.2	G	AE												
			Out List For Season 1															
			Advanced Notice for Season 2	1.7.2	G	AE												
			TAB Field Work															
			Prerequisite HVAC Work Check	1.7.2	G	AE												
			Out List For Season 2															
		23 07 00	SD-02 Shop Drawings															
			MICA Plates	3.2.2.4	G	RO												
			Pipe Insulation Systems	2.3														
			Pipe Insulation Systems	3.2														
			Duct Insulation Systems	3.3														
			Equipment Insulation Systems	3.5														
			Recycled content for insulation	2.3.1	S													
			materials															

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		23 07 00	SD-03 Product Data															
			Pipe Insulation Systems	2.3	G	AE												
			Pipe Insulation Systems	3.2	G	AE												
			Duct Insulation Systems	3.3	G	AE												
			Equipment Insulation Systems	3.5	G	AE												
			SD-04 Samples															
			Thermal Insulation	2.2.1.3	G	AE												
			Display Samples	3.1.1	G	AE												
			SD-07 Certificates															
			Indoor air quality for adhesives	2.2.1	S													
			SD-08 Manufacturer’s Instructions															
			Pipe Insulation Systems	2.3	G	AE												
			Pipe Insulation Systems	3.2	G	AE												
			Duct Insulation Systems	3.3	G	AE												
			Equipment Insulation Systems	3.5	G	AE												
		23 09 00	SD-02 Shop Drawings															
			DDC Contractor Design Drawings	3.3	G	AE												
			Draft As-Built Drawings	3.3	G	AE												
			Final As-Built Drawings	3.3	G	AE												
			SD-03 Product Data															
			Certificate of Networthiness	1.8.6	G	AE												
			Documentation															
			Programming Software	1.8.1	G	AE												
			Controller Application Programs	1.8.2	G	AE												
			Manufacturer's Product Data	2.2	G	AE												

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		23 09 00	Niagara Framework Supervisory Gateway Backups	1.8.4	G	AE												
			Niagara Framework Engineering Tool	1.8.5	G	AE												
			Niagara Framework Wizards	1.8.3	G	AE												
			SD-05 Design Data															
			Boiler Or Chiller Plant Gateway Request	1.9														
			SD-06 Test Reports															
			Existing Conditions Report	3.1.1														
			Start-Up Testing Report	3.5.2	G	AE												
			PVT Procedures	3.6.1	G	AE												
			PVT Report	3.6.3	G	AE												
			Pre-Construction Quality Control (QC) Checklist	1.10.1	G	AE												
			Post-Construction Quality Control (QC) Checklist	1.10.2	G	AE												
			Control Contractor’s Performance Verification Testing Plan	3.7.5	G	RO												
			Equipment Supplier’s Performance Verification Testing Plan	3.7.3.1	G	RO												
			Endurance Testing Results	3.7.8.3	G	RO												
			Performance Verification Test Report	3.7.9	G	RO												

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		23 09 00	SD-10 Operation and Maintenance															
			Data															
			Operation and Maintenance	3.8	G	AE												
			(O&M) Instructions															
			Training Documentation	3.10.1	G	AE												
			SD-11 Closeout Submittals															
			Enclosure Keys	2.5	G	AE												
			Password Summary Report	3.2.6.1	G	AE												
			Closeout Quality Control (QC)	1.10.3	G	AE												
			Checklist															
		23 11 20	SD-02 Shop Drawings															
			Gas Piping System	1.5.3	G	RO												
			Gas Piping System	2.2	G	RO												
			Gas Piping System	3.3	G	RO												
			SD-03 Product Data															
			Pipe and Fittings	1.6.1	G	RO												
			Gas Equipment Connectors	1.5.3	G	RO												
			Gas Piping System	1.5.3	G	RO												
			Gas Piping System	2.2	G	RO												
			Gas Piping System	3.3	G	RO												
			Pipe Coating Materials	2.1	G	RO												
			Pressure Regulators	2.6	G	RO												
			Risers	2.4	G	RO												
			Transition Fittings	2.2.10	G	RO												
			Valves	2.3	G	RO												
			Warning and Identification Tape	2.2.6	G	RO												

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		23 11 20	SD-06 Test Reports															
			Testing	3.19	G	RO												
			Pressure Tests	3.19.1	G	RO												
			Test with Gas	3.19.2	G	RO												
			SD-07 Certificates															
			Welders Procedures and	1.5.1	G	RO												
			Qualifications															
			Assigned Number, Letter, or	1.5.1	G	RO												
			Symbol															
			SD-08 Manufacturer's Instructions															
			PE Pipe and Fittings	1.5.2	G	RO												
			Pipe Coating Materials	2.1	G	RO												
			SD-10 Operation and Maintenance															
			Data															
			Gas Facility System and	1.3.1	G	RO												
			Equipment Operation															
			Gas Facility System Maintenance	1.3.2	G	RO												
			Gas Facility Equipment	1.3.3	G	RO												
			Maintenance															
		23 21 23	SD-02 Shop Drawings															
			System Coordination	2.1.2	G	AE												
			SD-03 Product Data															
			Instructions	2.2.2	G	AE												
			Equipment Data	2.2.5	G	AE												
			Training Period	3.5.2	G	AE												
			SD-06 Test Reports															

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		23 21 23	Factory Tests	2.1.1															
			Field Quality Control	3.3															
			SD-07 Certificates																
			Manufacturer's Representative	1.3.1															
			SD-10 Operation and Maintenance																
			Data																
			Operation and Maintenance	3.5.1	G	AE													
			Manuals																
			Training	3.5.2	G	AE													
		23 25 00	SD-03 Product Data																
			Water Treatment Systems	3.6.2	G	AE													
			Water Analysis	2.5	G	AE													
			Spare Parts	1.6															
			Field Instructions	3.5															
			Tests	3.6	G	AE													
			Training Course	3.5	G	AE													
			SD-07 Certificates																
			Chemical Treatment Contractor	1.4.1	G	RO													
			Qualifications																
			SD-10 Operation and Maintenance																
			Data																
			Water Treatment Systems	3.6.2															
		23 52 00	SD-02 Shop Drawings																
			Detail Drawings	1.5															
			SD-03 Product Data																
			Materials and Equipment	2.1.1															

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		23 52 00	Spare Parts	1.5														
			Heating System Tests	3.8														
			Fuel System Tests	3.11														
			Unit Heaters	2.5														
			Welding	1.3														
			Qualifications	3.8														
			Field Instructions	3.10														
			Tests	3.3														
			SD-06 Test Reports															
			Heating System Tests	3.8														
			Fuel System Tests	3.11														
			SD-07 Certificates															
			Bolts	2.8.5.3														
			SD-10 Operation and Maintenance															
			Data															
			Operation and Maintenance	3.10	G	AE												
			Instructions															
			SD-11 Closeout Submittals															
			Indoor Air Quality During	3.9.2	S													
			Construction															
		23 64 10	SD-03 Product Data															
			Air-Cooled Chiller	2.4	G	AE												
			Posted Instructions	3.1.3														
			Verification of Dimensions	1.6.1														
			System Performance Tests	3.5														
			Demonstrations	3.6														

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		23 64 10	Air-Cooled Chiller - Field	3.4.1															
			Acceptance Test Plan																
			SD-06 Test Reports																
			Field Acceptance Testing	3.4															
			Air-Cooled Chiller - Field	3.4.2															
			Acceptance Test Report																
			System Performance Tests	3.5															
			SD-07 Certificates																
			Ozone Depleting Substances	1.3.1															
			Technician Certification																
			SD-08 Manufacturer's Instructions																
			Air-Cooled Chiller - Installation	3.1	G	AE													
			Instructions																
			SD-10 Operation and Maintenance																
			Data																
			Operation and Maintenance	3.6	G	AE													
			Manuals																
			SD-11 Closeout Submittals																
			Indoor Air Quality During	3.3	S														
			Construction																
		23 64 26	SD-03 Product Data																
			Calibrated Balancing Valves	2.4.8	G	AE													
			Water Temperature Mixing Valve	2.4.9	G	AE													
			Water Temperature Regulating	2.4.10	G	AE													
			Valves																
			Water Pressure Reducing Valve	2.4.11															

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		23 64 26	Pressure Relief Valve	2.4.12														
			Combination Pressure and	2.4.13														
			Temperature Relief Valves															
			Expansion Joints	2.5.9	G	AE												
			Combination Strainer and Pump	2.5.3														
			Suction Diffuser															
			Expansion Tanks	2.6														
			Air Separator Tanks	2.7														
			SD-06 Test Reports															
			Piping Welds NDE Report	3.1.1.3														
			Pressure Tests Reports	3.4.2	G	AE												
			SD-07 Certificates															
			Employer's Record Documents	3.1.1.1														
			(For Welding)															
			Welding Procedures and	3.1.1.2														
			Qualifications															
			SD-08 Manufacturer’s Instructions															
			Lesson plan for the Instruction	3.5	G	AE												
			Course															
			SD-10 Operation and Maintenance															
			Data															
			Calibrated Balancing Valves	2.4.8	G	AE												
			Water Temperature Mixing Valve	2.4.9	G	AE												
			Water Temperature Regulating	2.4.10	G	AE												
			Valves															
			Water Pressure Reducing Valve	2.4.11	G	AE												

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		23 64 26	Pressure Relief Valve	2.4.12	G	AE												
			Combination Pressure and	2.4.13	G	AE												
			Temperature Relief Valves															
			Expansion Joints	2.5.9	G	AE												
			Combination Strainer and Pump	2.5.3	G	RO												
			Suction Diffuser															
			Expansion Tanks	2.6	G	AE												
			Air Separator Tanks	2.7	G	AE												
		23 81 23.00 20	SD-03 Product Data															
			Computer room air conditioning	2.1	G	AE												
			units															
			Space temperature control	2.2.2	G	AE												
			system drawings															
			SD-06 Test Reports															
			Field Test Schedule	3.3.2	G	AE												
			Manufacturer's Field Test Plans	3.3.1	G	AE												
			Field Test Reports	3.3.6	G	AE												
			SD-08 Manufacturer’s Instructions															
			Installation Manual for Each Type	3.1.2														
			of CRU															
			SD-10 Operation and Maintenance															
			Data															
			Computer Room Air Conditioning	2.1	G	AE												
			Units															
			SD-11 Closeout Submittals															

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		23 81 23.00 20	Indoor Air Quality During	3.2	S														
			Construction																
		25 05 11.21	SD-01 Preconstruction Submittals																
			Device Account Lock Exception	3.1.2.1	G	RO													
			Request																
			Multiple IP Connection Device	3.8	G	RO													
			Request																
			Contractor Computer	1.10.1.3	G	RO													
			Cybersecurity Compliance																
			Statements																
			Contractor Temporary Network	1.10.5	G	RO													
			Cybersecurity Compliance																
			Statements																
			SD-02 Shop Drawings																
			Network Communication Report	1.8.1	G	RO													
			Cybersecurity Riser Diagram	1.8.4	G	RO													
			Control System Inventory Report	1.8.2	G	RO													
			SD-03 Product Data																
			Control System Cybersecurity	1.8.5	G	RO													
			Documentation																
			SD-07 Certificates																
			Software Licenses	1.9	G	RO													
			Cybersecurity Representative's	1.7.1	G	RO													
			Certification Of Qualifications																
			SD-11 Closeout Submittals																
			Password Summary Report	3.5.2.2.3	G	RO													

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ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAG # RAPH	CLASSIFICATION	GOVT OR A/E REVWR	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION			APPROVING AUTHORITY					MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
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(a)	(b)	(c)	(d)	(e)	(f)		(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		25 05 11.21	Software Recovery And	1.8.3	G	RO												
			Reconstitution Images															
		25 05 11.23	SD-01 Preconstruction Submittals															
			Device Account Lock Exception	3.1.2.2	G	AE												
			Request															
			Multiple IP Connection Device	3.8	G	AE												
			Request															
			Contractor Computer	1.10.1.4	G	AE												
			Cybersecurity Compliance															
			Statements															
			Contractor Temporary Network	1.10.5	G	AE												
			Cybersecurity Compliance															
			Statements															
			SD-02 Shop Drawings															
			User Interface Banner Schedule	3.1.3.1	G	AE												
			Network Communication Report	1.8.2	G	AE												
			Cybersecurity Riser Diagram	1.8.5	G	AE												
			Control System Inventory Report	1.8.3	G	AE												
			Cybersecurity Interconnection	1.5.1	G	RO												
			Schedule															
			Cybersecurity Interconnection	1.8.1	G	RO												
			Schedule															
			SD-03 Product Data															
			Control System Cybersecurity	1.8.6	G	AE												
			Documentation															
			SD-07 Certificates															

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		25 05 11.23	Software Licenses	1.9	G	RO												
			Cybersecurity Representative's	1.7.1	G	RO												
			Certification Of Qualifications															
			SD-11 Closeout Submittals															
			Password Summary Report	3.5.2.2.5	G	RO												
			Software Recovery And	1.8.4	G	AE												
			Reconstitution Images															
			Device Audit Record Upload	3.2.2.1	G	RO												
			Software															
		25 10 10	SD-02 Shop Drawings															
			UMCS Contractor Design	3.2.3	G	RO												
			Drawings															
			Draft As-Built Drawings	3.2.4	G	RO												
			Final As-Built Drawings	3.2.4	G	RO												
			SD-03 Product Data															
			Product Data Sheets	2.1.5	G	RO												
			Computer Software	2.4	G	RO												
			Enclosure Keys	2.6.1														
			Certificate of Networthiness	3.2.2														
			Documentation															
			SD-05 Design Data															
			UMCS IP Network Bandwidth	3.2.1	G	RO												
			Usage Estimate															
			SD-06 Test Reports															
			Pre-Construction QC Checklist	1.6	G	RO												
			Post-Construction QC Checklist	1.6	G	RO												

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		25 10 10	Existing Conditions Report	3.1	G	RO												
			Start-Up and Start-Up Testing	3.6	G	RO												
			Report															
			PVT Phase I Procedures	3.7.1	G	RO												
			PVT Phase I Report	3.7.2	G	RO												
			PVT Phase II Report	3.7.3	G	RO												
			SD-10 Operation and Maintenance															
			Data															
			Operation and Maintenance	1.7	G	RO												
			(O&M) Instructions															
			Preventive Maintenance Work	3.8.8.1	G	RO												
			Plan															
			Basic Training Documentation	3.9.1	G	RO												
			Advanced Training	3.9.1	G	RO												
			Documentation															
			Refresher Training	3.9.1	G	RO												
			Documentation															
			SD-11 Closeout Submittals															
			Closeout QC Checklist	1.6	G	RO												
		26 08 00	SD-06 Test Reports															
			Acceptance tests and inspections	3.1	G	RO												
			SD-07 Certificates															
			Qualifications	1.4.1	G	RO												
			Acceptance test and inspections	1.4.3	G	RO												
			procedure															
		26 09 43	SD-02 Shop Drawings															

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		26 09 43	Detail Drawings	1.5	G	AE												
			SD-03 Product Data															
			Lighting Control Module	2.4	G	AE												
			Control Stations	2.5	G	AE												
			Low-Voltage Control Interfaces	2.6	G	AE												
			Wired Sensors	2.7	G	AE												
			Wireless Sensors	2.8	G	AE												
			Accessories	2.10	G	AE												
			SD-06 Test Reports															
			Source Quality Control	2.11														
			SD-07 Certificates															
			Warranty	1.11														
			Manufacturer Qualifications	1.7.1														
			SD-10 Operation and Maintenance															
			Data															
			Maintenance Material Submittals	1.12	G	RO												
			SD-11 Closeout Submittals															
			Closeout Activities	3.10														
			Maintenance	3.11														
		26 20 00	SD-02 Shop Drawings															
			Panelboards	2.11	G	RO												
			Transformers	2.13	G	RO												
			Wireways	2.26	G	RO												
			Marking Strips	3.1.9.1	G	RO												
			SD-03 Product Data															
			Receptacles	2.10	G	RO												

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		26 20 00	Circuit Breakers	2.11.3	G	RO												
			Switches	2.8	G	RO												
			Transformers	2.13	G	RO												
			Enclosed Circuit Breakers	2.12	G	RO												
			Motor Controllers	2.15	G	RO												
			Combination Motor Controllers	2.17.1	G	RO												
			Manual Motor Starters	2.16	G	RO												
			Grounding Busbar	2.21.3	G	RO												
			Surge Protective Devices	2.27	G	RO												
			SD-06 Test Reports															
			600-volt Wiring Test	3.5.2	G	RO												
			Grounding System Test	3.5.6	G	RO												
			Transformer Tests	3.5.3	G	RO												
			Ground-fault Receptacle Test	3.5.4	G	RO												
			Arc-fault Receptacle Test	3.5.5	G	RO												
			SD-07 Certificates															
			Fuses	2.9	G	RO												
			SD-09 Manufacturer’s Field															
			Reports															
			Transformer Factory Tests	2.29.1														
			SD-10 Operation and Maintenance															
			Data															
			Electrical Systems	1.5.1	G	RO												
		26 24 13	SD-02 Shop Drawings															
			Switchboard Drawings	1.5.2	G	RO												
			SD-03 Product Data															

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		26 24 13	Switchboard	2.2	G	RO												
			SD-06 Test Reports															
			Switchboard Design Tests	2.5.2	G	RO												
			Switchboard Production Tests	2.5.3	G	RO												
			Acceptance Checks and Tests	3.5.1	G	RO												
			SD-10 Operation and Maintenance															
			Data															
			Switchboard Operation and	1.6.1	G	RO												
			Maintenance															
			SD-11 Closeout Submittals															
			Assembled Operation and	1.6.2	G	RO												
			Maintenance Manuals															
			Equipment Test Schedule	2.5.1	G	RO												
			Request for Settings	3.5	G	RO												
			Service Entrance Available Fault	2.8	G	RO												
			Current Label															
		26 28 01.00 10	SD-03 Product Data															
			Fault Current Analysis	2.9	G	RO												
			Protective Device Coordination	2.9	G	RO												
			Study															
			Equipment	2.1	G	RO												
			System Coordinator	1.4.1														
			Installation	3.2														
			SD-06 Test Reports															
			Field Testing	3.3														
			SD-07 Certificates															

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		26 28 01.00 10	Devices and Equipment	1.6															
		26 29 23	SD-02 Shop Drawings																
			Schematic Diagrams	1.6.1	G	AE													
			Interconnecting Diagrams	1.6.2	G	AE													
			Installation Drawings	1.6.3	G	AE													
			Harmonic Distortion Analysis	2.7	G	RO													
			SD-03 Product Data																
			Variable Frequency Drives	2.1	G	RO													
			Harmonic Passive Filters (HPF)	2.6	G	RO													
			Wires and Cables	2.3															
			Equipment Schedule	1.6.4															
			SD-06 Test Reports																
			VFD Test	3.2.1															
			Performance Verification Tests	3.2.2															
			Endurance Test	3.2.3															
			SD-08 Manufacturer’s Instructions																
			Installation instructions	1.6.5															
			SD-09 Manufacturer’s Field																
			Reports																
			VFD Factory Test Plan	2.5.1	G	RO													
			Factory test results	1.6.6															
			SD-10 Operation and Maintenance																
			Data																
			Variable Frequency Drives	2.1															
		26 32 15.00 10	SD-02 Shop Drawings																
			Detailed Drawings	1.3.6	G	RO													

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		26 32 15.00 10	Acceptance	3.8	G	RO												
			SD-03 Product Data															
			Engine-Generator Parameter	2.1.1														
			Schedule															
			Heat Exchanger	2.8.2	G	RO												
			Generator	2.16	G	RO												
			Temporary Generator Connection	2.27														
			Cabinet															
			Manufacturer's Catalog	2.5														
			Site Welding	1.3.2														
			Spare Parts	1.5														
			Onsite Training	3.6														
			Vibration-Isolation	2.1.7														
			Experience	1.3.4														
			Field Engineer	1.3.5														
			General Installation	3.2														
			SD-05 Design Data															
			Performance Criteria	2.16														
			Sound Limitations	2.9	G	RO												
			Integral Main Fuel Storage Tank	2.6.4														
			Power Factor	3.5.1.2														
			Time-Delay on Alarms	2.20.5														
			Battery Charger	2.14.3.2														
			SD-06 Test Reports															
			Factory Inspection and Tests	2.28														
			Factory Tests	2.28.2														

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		26 32 15.00 10	Onsite Inspection and Tests	3.5	G	RO												
			SD-07 Certificates															
			Cooling System	2.8														
			Cooling System	2.8														
			Vibration Isolation	2.1.7														
			Prototype Test	2.28.2														
			Reliability and Durability	2.1.5														
			Emissions	2.13														
			Sound Limitations	2.9														
			Site Visit	3.1														
			Current Balance	2.16.1														
			Materials and Equipment	2.4														
			Inspections	3.5.3														
			SD-10 Operation and Maintenance															
			Data															
			Operation and Maintenance	3.6	G	RO												
			Manuals															
			Maintenance Procedures	3.6	G	RO												
			Special Tools	2.15														
			Filters	2.7.2														
		26 36 00.00 10	SD-02 Shop Drawings															
			Detail Drawings	1.3.1														
			Equipment	2.1														
			Installation	3.1														
			SD-03 Product Data															
			Equipment	2.1														

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		26 36 00.00 10	SD-06 Test Reports																
			Testing	2.5	G	RO													
			SD-07 Certificates																
			Equipment	2.1															
			Switching Equipment	1.3.2															
			SD-10 Operation and Maintenance																
			Data																
			Switching Equipment	1.3.2	G	RO													
			Instructions	3.2	G	RO													
		26 41 00	SD-02 Shop Drawings																
			Overall lightning protection	1.4.1.1	G	RO													
			system																
			Each major component	1.4.1.2	G	RO													
			SD-06 Test Reports																
			Lightning Protection and	1.4.3	G	RO													
			Grounding System Test Plan																
			Lightning Protection and	3.5.1	G	RO													
			Grounding System Test																
			SD-07 Certificates																
			Lightning Protection System	1.2.3	G	RO													
			Installers Documentation																
			Component UL Listed and	1.4.2	G	RO													
			Labeled																
			Lightning protection system	1.4.4	G	RO													
			inspection certificate																
			Roof manufacturer's warranty	3.1.1	G	RO													

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		26 51 00	SD-02 Shop Drawings															
			Luminaire Drawings	1.5.1	G	RO												
			Occupancy/Vacancy Sensor	1.5.2	G	RO												
			Coverage Layout															
			SD-03 Product Data															
			Luminaires	2.2	G	RO												
			Light Sources	2.4	G	RO												
			LED Luminaire Warranty	1.6.1	G	RO												
			Luminaire Design Data	1.5.4	G	RO												
			Dimming Controllers (Dimmers)	2.5.2	G	RO												
			Exit Signs	2.6.1	G	RO												
			Occupancy Sensors	2.5.3.1	G	RO												
			Ambient Light Level Sensor	3.1.8	G	RO												
			SD-06 Test Reports															
			LED Luminaire - IES LM-79 Test	1.5.5	G	RO												
			Report															
			LED Light Source - IES LM-80	1.5.6	G	RO												
			Test Report															
			LED Light Source - IES TM-21	1.5.7	G	RO												
			Test Report															
			Occupancy/Vacancy Sensor	1.5.8	G	RO												
			Verification Tests															
			Energy Efficiency	1.5.11.3	G	RO												
			SD-07 Certificates															
			Luminaire Useful Life Certificate	1.6.1.1	G	RO												

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		26 51 00	LED Driver and Dimming Switch	1.5.3	G	RO												
			Compatibility Certificate															
		26 56 00	SD-01 Preconstruction Submittals															
			Photometric Plan	1.5.2	G	RO												
			LED Luminaire Warranty	1.6.1	G	RO												
			SD-02 Shop Drawings															
			Luminaire Drawings	1.5.1.1	G	RO												
			SD-03 Product Data															
			LED Luminaires	2.2	G	RO												
			Luminaire Light Sources	2.2.2	G	RO												
			Luminaire Power Supply Units	2.2.3	G	RO												
			(Drivers)															
			Photocell	2.3.1	G	RO												
			Brackets	2.4														
			SD-05 Design Data															
			Design Data for Luminaires	1.5.3	G	RO												
			SD-06 Test Reports															
			LED Luminaire - IES LM-79 Test	1.5.4	G	RO												
			Report															
			LED Light Source - IES LM-80	1.5.5	G	RO												
			Test Report															
			Operating Test	3.2														
			SD-07 Certificates															
			Luminaire Useful Life Certificate	1.6.1	G	RO												
		27 05 14.00 10	SD-02 Shop Drawings															

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ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAG # RAPH	CLASSIFICATION	GOVT OR A/E REVWR	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION			APPROVING AUTHORITY				MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
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		27 05 14.00 10	Cable TV Premises Distribution	1.2	G	RO												
			System															
			Installation	3.1	G	RO												
			SD-03 Product Data															
			Spare Parts	1.7														
			Test Plan	3.4	G	RO												
			Qualifications	1.4														
			SD-06 Test Reports															
			Testing	3.4														
			SD-07 Certificates															
			Materials and Equipment	2.1														
			SD-08 Manufacturer’s Instructions															
			Manufacturer's	3.1.2														
			Recommendations															
			SD-10 Operation and Maintenance															
			Data															
			Operation and Maintenance	3.5	G	RO												
			Manuals															
		27 05 28.36 40	SD-02 Shop Drawings															
			Fabrication Drawings	2.2	G	RO												
			Installation Drawings	3.1.2	G	RO												
			SD-03 Product Data															
			Cable Trays	1.2.1	G	RO												
			Supports	1.2.1	G	RO												
			SD-08 Manufacturer’s Instructions															
			Manufacturer's Instructions	3.1.1														

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		27 10 00	SD-02 Shop Drawings															
			Telecommunications drawings	1.6.1.1	G	RO												
			Telecommunications Space	1.6.1.2	G	RO												
			Drawings															
			SD-03 Product Data															
			Telecommunications cabling	2.3	G	RO												
			Patch panels	2.4.5	G	RO												
			Telecommunications	2.5	G	RO												
			outlet/connector assemblies															
			Equipment support frame	2.4.2	G	RO												
			Connector blocks	2.4.3	G	RO												
			Spare Parts	1.10.3	G	RO												
			SD-06 Test Reports															
			Telecommunications cabling	3.5.1	G	RO												
			testing															
			SD-07 Certificates															
			Telecommunications Contractor	1.6.2.1	G	RO												
			Key Personnel	1.6.2.2	G	RO												
			Manufacturer Qualifications	1.6.2.3	G	RO												
			Test plan	1.6.3	G	RO												
			SD-09 Manufacturer's Field															
			Reports															
			Factory reel tests	2.10.1	G	RO												
			SD-10 Operation and Maintenance															
			Data															

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		27 10 00	Telecommunications cabling and	1.10.1	G	RO												
			pathway system															
			SD-11 Closeout Submittals															
			Record Documentation	1.10.2	G	RO												
		27 51 16	SD-02 Shop Drawings															
			Detail Drawings	2.1.4	G	RO												
			SD-03 Product Data															
			Spare Parts	1.4														
			SD-06 Test Reports															
			Approved Test Procedures	3.5	G	RO												
			Acceptance Tests	3.5														
			SD-07 Certificates															
			Components	2.2														
			SD-10 Operation and Maintenance															
			Data															
			Radio and Public Address	2.1	G	RO												
			System															
		28 08 10	SD-05 Design Data															
			Test Plan	3.1	G	RO												
			SD-06 Test Reports															
			Draft Test Report	3.2.2														
			Final Test Report	3.4	G	RO												
			SD-07 Certificates															
			Qualifications	1.4.1														
		28 10 05	SD-02 Shop Drawings															
			ESS Components	1.3.3.1	G	RO												

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		28 10 05	Overall System Schematic	1.3.3.2	G	RO												
			SD-03 Product Data															
			Premise Control Unit	2.3.6	G	RO												
			Detection Sensors	2.3.7	G	RO												
			Access Control Unit	2.4.4	G	RO												
			Access Control Devices	2.4.5	G	RO												
			Communications Interface	2.5	G	RO												
			Devices															
			Network Switch	2.5.4	G	RO												
			Video and ESS Transmission	2.5.5	G	RO												
			Batteries	2.6.1	G	RO												
			Component Enclosure	2.8	G	RO												
			Equipment Rack	2.9	G	RO												
			SD-05 Design Data															
			Backup Battery Capacity	1.5.1	G	RO												
			Calculations															
			Throughput Rates	2.4.2	G	RO												
			SD-07 Certificates															
			Contractor Qualifications	1.3.4.1	G	RO												
			Instructor Qualifications	1.3.4.2	G	RO												
			Data Encryption	2.5.3	G	RO												
			SD-10 Operation and Maintenance															
			Data															
			Training Plan	3.6.1	G	RO												
			Training Content	3.6	G	RO												
			ESS Components	1.3.3.1	G	RO												

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		28 10 05	ESS Software	1.6	G	RO												
			SD-11 Closeout Submittals															
			As-Built Drawings	1.7	G	RO												
		28 31 76	SD-02 Shop Drawings															
			Nameplates	2.1.2	G	AE												
			Instructions	2.16.9	G	AE												
			Wiring Diagrams	3.2.1	G	AE												
			System Layout	1.2.1	G	AE												
			System Operation	2.3	G	AE												
			Notification Appliances	2.20	G	AE												
			Amplifiers	2.17	G	AE												
			SD-03 Product Data															
			Carbon Monoxide Detector	2.12	G	AE												
			Technical Data And Computer	1.6	G	AE												
			Software															
			Fire Alarm Control Unit and Mass	2.15	G	AE												
			Notification Control Unit (FMCP)															
			LCD, LED Display Unit (VDU)	2.3.2	G	AE												
			Terminal Cabinets	3.2.2	G	AE												
			Manual Stations	2.19	G	AE												
			Transmitters	2.23	G	AE												
			Batteries	2.14.1	G	AE												
			Battery Chargers	2.14.2	G	AE												
			Smoke Sensors	2.10	G	AE												
			Heat Detectors	2.11	G	AE												
			Notification Appliances	2.20	G	AE												

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		28 31 76	Addressable Interface Devices	2.7	G	AE												
			Amplifiers	2.17	G	AE												
			Tone Generators	2.17	G	AE												
			Digitalized Voice Generators	2.17	G	AE												
			Remote Fire Alarm/Mass	2.16	G	AE												
			Notification Control Units															
			Radio Transmitter and Interface	2.23.1	G	AE												
			Panels															
			Local Operating Console (LOC)	1.4.4	G	AE												
			SD-05 Design Data															
			Battery Power	2.14.1.2	G	AE												
			Battery Chargers	2.14.2	G	AE												
			SD-06 Test Reports															
			Field Quality Control	3.7														
			Testing Procedures	3.7.1	G	AE												
			Smoke Sensor Testing	2.10.4	G	AE												
			SD-07 Certificates															
			Fire Protection Engineering	1.7.1.1														
			Installer	1.7.1.4														
			Formal Inspection and Tests	3.7.2.2														
			Final Testing	3.7.2.3														
			SD-09 Manufacturer's Field															
			Reports															
			System Operation	2.3	G	AE												
			Fire Alarm/Mass Notification	1.7.2.2														
			System															

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		28 31 76	SD-10 Operation and Maintenance																
			Data																
			Operation and Maintenance	3.10	G	AE													
			(O&M) Instructions																
			Instruction of Government	3.8	G	AE													
			Employees																
			SD-11 Closeout Submittals																
			As-Built Drawings	3.7.2.4															
		31 00 00	SD-01 Preconstruction Submittals																
			Shoring	3.3	G	RO													
			Dewatering Work Plan	1.3.3	G	RO													
			SD-03 Product Data																
			Utilization of Excavated Materials	3.6	G	RO													
			Rock Excavation	1.3.1.2															
			SD-06 Test Reports																
			Testing	3.13															
			Borrow Site Testing	2.1															
			SD-07 Certificates																
			Testing	3.13															
		31 05 19	SD-03 Product Data																
			Thread	2.1.2															
			Manufacturing Quality Control	2.2															
			Sampling and Testing																
			SD-04 Samples																
			Quality Assurance Samples and	3.1															
			Tests																

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		31 05 19	SD-07 Certificates																
			Geotextile	2.1.1															
		32 11 23	SD-03 Product Data																
			Plant, Equipment, and Tools	1.4	G	RO													
			SD-06 Test Reports																
			Initial Tests	2.3.1	G	RO													
			In-Place Tests	3.11.1	G	EO													
		32 12 13	SD-03 Product Data																
			Local/Regional Materials	2.2.2															
			SD-06 Test Reports																
			Sampling and Testing	3.7															
		32 12 16	SD-03 Product Data																
			Mix Design	2.4	G	RO													
			Quality Control	3.5	G	RO													
			Material Acceptance	3.6	G	RO													
			SD-04 Samples																
			Asphalt Cement Binder	2.3															
			Aggregates	2.2															
			SD-06 Test Reports																
			Aggregates	2.2	G	RO													
			QC Monitoring	3.5.2.4															
			SD-07 Certificates																
			Asphalt Cement Binder	2.3	G	RO													
		32 16 19	SD-03 Product Data																
			Concrete	2.1															

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		32 16 19	Biodegradable Form Release	2.6.4															
			Agent																
			Biodegradable Form Release	3.2															
			Agent																
			SD-06 Test Reports																
			Field Quality Control	3.7															
		32 17 23	SD-03 Product Data																
			Surface Preparation Equipment	2.1.1	G	RO													
			List																
			Application Equipment List	2.1.2	G	RO													
			Exterior Surface Preparation	3.2															
			Safety Data Sheets	1.3.1	G	RO													
			Waterborne Paint	2.2.1	G	RO													
			Thermoplastic compound	2.2.2	G	RO													
			Thermoplastic compound	3.3.2	G	RO													
			SD-06 Test Reports																
			Waterborne Paint	2.2.1	G	RO													
			Thermoplastic Compound	2.2.2	G	RO													
			Thermoplastic Compound	3.3.2	G	RO													
			Test Reports	3.4.1															
			SD-07 Certificates																
			Qualifications	1.3.2	G	RO													
			Waterborne Paint	2.2.1															
			Volatile Organic Compound	1.3.1	G	RO													
			Thermoplastic Compound	2.2.2															
			Thermoplastic Compound	3.3.2															

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		32 17 23	SD-08 Manufacturer's Instructions															
			Waterborne Paint	2.2.1	G	RO												
			Thermoplastic Compound	2.2.2	G	RO												
			Thermoplastic Compound	3.3.2	G	RO												
		32 31 13	SD-02 Shop Drawings															
			Fence Assembly	2.1	G	RO												
			Location of Gate, Corner, End,	3.2.1.1	G	RO												
			and Pull Posts															
			Gate Assembly	2.1	G	RO												
			Gate Hardware and Accessories	2.2.13	G	RO												
			Erection/Installation Drawings	Part 3	G	RO												
			SD-03 Product Data															
			Fence Assembly	2.1	G	RO												
			Gate Assembly	2.1	G	RO												
			Gate Hardware and Accessories	2.2.13	G	RO												
			Zinc Coating	2.3.1	G	RO												
			Fabric	2.2.1	G	RO												
			Stretcher Bars	2.2.8	G	RO												
			Concrete	2.3.3	G	RO												
			SD-04 Samples															
			Fabric	2.2.1	G	RO												
			SD-07 Certificates															
			Certificates of Compliance	1.3.1														
			SD-08 Manufacturer's Instructions															
			Fence Assembly	2.1														
			Gate Assembly	2.1														

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		32 31 13	Hardware Assembly	2.1														
			Accessories	2.1														
			SD-11 Closeout Submittals															
			Recycled Material Content	3.3	S	RO												
		32 92 19	SD-03 Product Data															
			Wood Cellulose Fiber Mulch	2.5.3	G	RO												
			Fertilizer	2.4	G	RO												
			SD-06 Test Reports															
			Topsoil Composition Tests	2.2.3	G	RO												
			SD-07 Certificates															
			Seed	2.1	G	RO												
			SD-08 Manufacturer’s Instructions															
			Erosion Control Materials	2.7	G	RO												
		32 92 23	SD-03 Product Data															
			Fertilizer	2.4	G	RO												
			SD-06 Test Reports															
			Topsoil composition tests	2.2.3	G	RO												
			SD-07 Certificates															
			sods	2.1	G	RO												
		32 93 00	SD-01 Preconstruction Submittals															
			State Landscape Contractor's	1.4.3														
			License															
			Time Restrictions and Planting	1.6														
			Conditions															
			SD-03 Product Data															
			Peat	2.3.5	G	RO												

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		32 93 00	Composted Derivatives	2.3.8															
			Rotted Manure	2.3.10															
			Organic Mulch Materials	2.6.2	G	RO													
			Mulch	2.6	G	RO													
			Ground Stakes	2.7.1.2															
			Fertilizer	2.5	G	RO													
			Root Control Barrier	2.10	G	RO													
			Staking Material	2.7.1															
			Metal Anchors	2.7.7															
			Antidesiccants	2.8															
			Erosion Control Materials	2.9															
			Photographs	1.4.4	G	RO													
			SD-04 Samples																
			Mulch	2.6	G	RO													
			SD-06 Test Reports																
			Topsoil Composition Tests	2.2.4	G	RO													
			Percolation Test	1.4.5															
			SD-07 Certificates																
			Nursery Certifications	2.1.1															
			SD-10 Operation and Maintenance																
			Data																
			Plastic Identification	1.8															
		33 40 00	SD-02 Shop Drawings																
			Reinforced Precast Concrete	2.3.5	G	RO													
			Manholes																

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CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAG # RAPH	CLASSIFICATION	GOVT OR A/E REVWR	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION			APPROVING AUTHORITY					MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
							SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION	DATE FWD TO APPR AUTH/ DATE RCD FROM CONTR	DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION		
(a)	(b)	(c)	(d)	(e)	(f)		(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		33 40 00	Precast Reinforced Concrete	2.2.1	G	RO												
			Storm Inlets and Structures															
			Frames, Covers, and Grates	2.3.6	G	RO												
			SD-03 Product Data															
			Reinforced Precast Concrete	2.3.5														
			Manholes															
			Precast Reinforced Concrete	2.2.1														
			Storm Inlets and Structures															
			Frames, Covers, and Grates	2.3.6														
			Pipe for Culverts and Storm	2.1														
			Drains															
			SD-04 Samples															
			Pipe for Culverts and Storm	2.1														
			Drains															
			SD-06 Test Reports															
			Infiltration Tests And Exfiltration	3.9.1	G	RO												
			Tests															
			Deflection Testing	3.9.1.3														
			Hydrostatic Test	3.9.1.1.1	G	RO												
			SD-07 Certificates															
			Resin Certification	2.1.1														
			Resin Certification	2.1.2														
			Oil Resistant Gasket	2.3.7.1														
			Leakage Test	3.9.3.1														
			Hydrostatic Test on Watertight	3.9.1.1														
			Joints															

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION
Cullum Hall

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH #	CLASSIFICATION	GOVT OR A/E REVWR	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION			APPROVING AUTHORITY				MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
							SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION	DATE FWD TO APPR AUTH/ DATE RCD FROM CONTR	DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION		
(a)	(b)	(c)	(d)	(e)	(f)		(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		33 40 00	Determination of Density	3.9.1.2														
			Frame and Cover for Gratings	2.3.6														
			Post-Installation Inspection	3.9.2.1.2														
			Report															
			SD-11 Closeout Submittals															
			As-Built Drawings	3.12	G	RO												
		33 71 02	SD-02 Shop Drawings															
			Precast underground structures	1.6.1	G	RO												
			SD-03 Product Data															
			Precast concrete structures	2.9.2.1	G	RO												
			Sealing Material	2.9.2.4														
			Pulling-In Irons	3.5.2														
			Manhole frames and covers	2.9.3	G	RO												
			Composite/fiberglass handholes	2.9.5	G	RO												
			Cable supports	2.10	G	RO												
			Protective Devices and	2.12	G	RO												
			Coordination															
			SD-06 Test Reports															
			Field Acceptance Checks and	3.15.1	G	RO												
			Tests															
			Arc-proofing test	2.13.1	G	RO												
			Cable Installation Plan and	3.3	G	RO												
			Procedure															
		33 82 00	SD-02 Shop Drawings															
			Telecommunications Outside	1.6.1.1	G	RO												
			Plant															

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION
Cullum Hall

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAG # RAPH	CLASSIFICATION	GOVT OR A/E REVWR	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION			APPROVING AUTHORITY					MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
							SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION	DATE FWD TO APPR AUTH/ DATE RCD FROM CONTR	DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION		
(a)	(b)	(c)	(d)	(e)	(f)		(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		33 82 00	Telecommunications Entrance	1.6.1.2	G	RO												
			Facility Drawings															
			SD-03 Product Data															
			Wire and cable	2.7	G	RO												
			Cable splices, and connectors	2.4	G	RO												
			Closures	2.3	G	RO												
			Building protector assemblies	2.2.1	G	RO												
			Protector modules	2.2.2	G	RO												
			Spare Parts	1.8.2	G	RO												
			SD-06 Test Reports															
			Pre-installation tests	3.5.1	G	RO												
			Acceptance tests	3.5.2	G	RO												
			Outside Plant Test Plan	1.6.3	G	RO												
			SD-07 Certificates															
			Telecommunications Contractor	1.6.2.1	G	RO												
			Key Personnel	1.6.2.2	G	RO												
			Manufacturer's Qualifications	1.6.2.3	G	RO												
			SD-08 Manufacturer’s Instructions															
			Building protector assembly	2.2.1	G	RO												
			installation															
			Cable tensions	3.1.7.1	G	RO												
			Fiber Optic Splices	3.1.8.2	G	RO												
			SD-09 Manufacturer’s Field															
			Reports															
			Factory Reel Test Data	2.13.1	G	RO												

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION
Cullum Hall

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAG # PARAPH	CLASSIFICATION	GOVT OR A/E REVWR	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION			APPROVING AUTHORITY					MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
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		33 82 00	SD-10 Operation and Maintenance																
			Data																
			Telecommunications outside	1.6.1.1	G	RO													
			plant (OSP)																
			SD-11 Closeout Submittals																
			Record Documentation	1.8.1	G	RO													

SECTION 01 35 91

HISTORIC TREATMENT PROCEDURES
12/17

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF SAFETY PROFESSIONALS (ASSP)

ASSP A10.6	(2006) Safety & Health Program Requirements for Demolition Operations - American National Standard for Construction and Demolition Operations

NATIONAL PARK SERVICE (NPS)

NPS Hist Prop	(2017) National Standards for the Treatment of Historic Properties with Guidelines for Preserving, Rehabilitating, Restoring, and Reconstructing Historic Buildings

1.2 DEFINITIONS

Conservation or Conserve: To stabilize or restore existing materials to minimize deterioration or to bring the material closer to its original appearance. Treatments should be reversible to the greatest extent possible and not damage the integrity of the existing material.

Consolidate: To strengthen loose or deteriorated materials in place.

Design Reference Sample: A sample that represents the Architect's pre-bid selection of work to be matched; it may be existing work or work specially produced for the Project.

Dismantle: To disassemble or detach a historic item from a surface, or a non-historic item from a historic surface, using gentle methods and equipment to prevent damage to historic items and surfaces; disposing of items unless indicated to be salvaged or reinstalled.

"Existing to Remain" or Retain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed and salvaged, or removed and reinstalled.

Historic: Spaces, areas, rooms, surfaces, materials, finishes, and overall appearance that are important to the successful preservation and rehabilitation as determined by Architect. Designated historic areas are indicated on Drawings.

Match: To blend with adjacent construction and manifest no apparent difference in material type, species, cut, form, detail, color, grain, texture, or finish; as approved by Architect.

"Material in Kind": Material that matches existing materials, as much as possible, in species, cut, color, grain, and finish.

Preservation: To apply measures necessary to sustain the existing form, integrity, and materials of a historic property. Work may include preliminary measures to protect and stabilize the property..

"Protect and Maintain": To remove deteriorating corrosion, reapply protective coatings, and install protective measures such as temporary guards; to provide the least degree of intervention.

Reconstruction: To reproduce in the exact form and detail a building, structure, or artifact as it appeared at a specific period in time..

Refinish: To remove existing finishes to base material and apply new finish to match original, or as otherwise indicated..

Rehabilitation: To make possible a compatible use for a property through repair, alterations, and additions while preserving those portions or features that convey its historical, cultural, or architectural values.

Reinstall: To protect removed or dismantled item, repair and clean it as indicated for reuse, and reinstall it in original position, or where indicated.

Remove: To take down or detach a non-historic item located within a historic space, area, or room, using methods and equipment to prevent damage to historic items and surfaces; disposing of items unless indicated to be salvaged or reinstalled..

"Remove and Reinstall": To detach items from existing construction, repair and clean them for reuse, and reinstall them where indicated..

"Remove and Salvage": To detach items from existing construction and deliver them to Owner ready for reuse..

Repair: To correct damage and defects, retaining existing materials, features, and finishes while employing as little new material as possible. This includes patching, piecing-in, splicing, consolidating, or otherwise reinforcing or upgrading materials..

Replace: To remove, duplicate, and reinstall entire item with new material. The original item is the pattern for creating duplicates unless otherwise indicated..

Replicate: To reproduce in exact detail, materials, and finish unless otherwise indicated..

Reproduce: To fabricate a new item, accurate in detail to the original, and from either the same or a similar material as the original, unless otherwise indicated..

Restore: To consolidate, replicate, reproduce, repair, and refinish as required to achieve the indicated results..

Retain: To keep existing items that are not to be removed or dismantled..

Reversible: New construction work, treatments, or processes that can be

removed or undone in the future without damaging historic materials unless otherwise indicated..

Salvage: To protect removed or dismantled items and deliver them to Owner ready for reuse..

Stabilize: To provide structural reinforcement of unsafe or deteriorated items while maintaining the essential form as it exists at present; also, to reestablish a weather-resistant enclosure..

Strip: To remove existing finish down to base material unless otherwise indicated.

1.3 COORDINATION

1.3.1 Historic Treatment Sub-schedule

A construction schedule coordinating the sequencing and scheduling of historic treatment work for entire Project, including each activity to be performed in historic spaces, areas, and rooms, and on historic surfaces; and based on Contractor's Construction Schedule. Secure time commitments for performing critical construction activities from separate entities responsible for historic treatment work.

1. Schedule construction operations in sequence required to obtain best historic treatment results
2. Coordinate sequence of historic treatment work activities to accommodate the following:

    a. Other known work in progress
    b. Tests and inspections.

3. Detail sequence of historic treatment work, with start and end dates.
4. Utility Services: Indicate how long utility services will be interrupted. Coordinate shutoff, capping, and continuation of utility services.
5. Use of egress paths.

1.3.2 Public Circulation

Coordinate historic treatment work with public circulation patterns at Project site. Plan and execute the Work accordingly.

1.4 PROJECT MEETINGS FOR HISTORIC TREATMENT

1.4.1 Preliminary Historic Treatment Conference

Before starting historic treatment work, Architect and Historic Preservation Consultant shall conduct conference at Project site.

1. Attendees: In addition to representatives of Owner, Architect, Historic Preservation Consultant, Contractor, historic treatment specialists, chemical-cleaner manufacturer and installers whose work interfaces with or affects historic treatment shall be represented at the meeting.
2. Agenda: Discuss items of significance that could affect progress of historic treatment work, including review of the following:

    a. Historic Treatment Sub-schedule: Discuss and finalize; verify

availability of materials, historic treatment specialists' personnel, equipment, and facilities needed to make progress and avoid delays.
b. Fire-prevention plan.
c. Governing regulations.
d. Areas where existing construction is to remain and the required protection.
e. Hauling routes.
f. Sequence of historic treatment work operations.
g. Storage, protection, and accounting for salvaged and specially fabricated items.
h. Existing conditions, staging, and structural loading limitations of areas where materials are stored.
i. Qualifications of personnel assigned to historic treatment work and assigned duties.
j. Requirements for extent and quality of work, tolerances, and required clearances.
k. Methods and procedures related to historic treatments, including product manufacturers' written instructions and precautions regarding historic treatment procedures and their effects on materials and components.
l. Special details, collection of wastes, protection of occupants and the public, and condition of other construction that affects the Work or will affect the work.

3. Reporting: Architect will record conference results and distribute copies to everyone in attendance and to others affected by decisions or actions resulting from conference.

1.4.2 Coordination Meetings

Conduct coordination meetings specifically for historic treatment work at periodic intervals, as appropriate to the Project. Coordination meetings are in addition to specific meetings held for other purposes, such as progress meetings and pre-installation conferences.

1.4.2.1 Attendees

In addition to representatives of Owner, Architect, Historic Preservation Consultant and Contractor, each historic treatment specialist, supplier, installer, and other entity concerned with progress or involved in planning, coordination, or performance of historic treatment work activities shall be represented at these meetings. All participants at conference shall be familiar with Project and authorized to conclude matters relating to historic treatment work.

1.4.2.2 Agenda

Review and correct or approve minutes of previous coordination meeting. Review other items of significance that could affect progress of historic treatment work. Include topics for discussion as appropriate to status of Project.

a. Historic Treatment Sub-schedule: Review progress since last coordination meeting. Determine whether each schedule item is on time, ahead of schedule, or behind schedule. Determine how construction behind schedule will be expedited with retention of quality; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent

activities are completed within the Contract Time.
b. Schedule Updating: Revise Contractor's Historic Treatment Sub-schedule after each coordination meeting where revisions to schedule have been made or recognized. Issue revised schedule concurrently with report of each meeting.
c. Review present and future needs of each entity present, including review items listed in the "Preliminary Historic Treatment Conference" Paragraph above and the following:

1) Interface requirements of historic treatment work with other Project Work.
2) Status of submittals for historic treatment work.
3) Access to historic treatment work.
4) Effectiveness of fire-prevention plan.
5) Quality and work standards of historic treatment work.
6) Change Orders for historic treatment work.

1.4.2.3 Reporting

Record meeting results and distribute copies to everyone in attendance and to others affected by decisions or actions resulting from each meeting

1.5 MATERIALS OWNERSHIP

Historic items, relics, and similar objects including, but not limited to commemorative plaques and tablets, antiques, and other items of interest or value to Owner that may be encountered or uncovered during the Work, regardless of whether they were previously documented, remain Owner's property

1. Carefully dismantle and salvage each item or object and protect it from damage, then promptly deliver it to Owner where directed.
2. Coordinate with Owner's historical adviser, who will establish special procedures for dismantling and salvaging.

1.6 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals with an "S" are for inclusion in the Sustainability Notebook, in conformance with Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

Construction Schedule for Historic Treatment: A minimum of 15 days prior to commencement of Work submit a schedule for the Project indicating the following for each activity to be performed in historic spaces, areas, rooms and surfaces:

1. Detailed sequence of historic treatment work, with starting and ending dates, coordinated with Owner's continuing operations and other known work in progress.
2. Utility Services: Indicate how long utility services will be interrupted.

~~Photographic Documentation:~~

~~1. Preconstruction Photos: Prior to start of work show existing~~

~~conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by historic treatment operations.~~

~~2. Progress Photos: Provide Architect with progress photos documenting construction processes related to historic fabric. Photos shall be submitted on a bi-weekly basis or as construction procedures and progress dictate.~~

Historic Treatment Program: Prepare a written plan for historic treatment for whole Project, including each phase or process and protection of surrounding materials during operations. Describe in detail the materials, methods, and equipment to be used for each phase of work. Show compliance with indicated methods and procedures specified in this and other Sections. Coordinate this whole-Project historic treatment program with specific requirements of programs required in other historic treatment Sections.

1. Dust and Noise Control: Include locations of proposed temporary dust- and noise-control partitions and means of egress from occupied areas coordinated with continuing on-site operations and other known work in progress.
2. Debris Hauling: Include plans clearly marked to show debris hauling routes, turning radii, and locations and details of temporary protective barriers.

~~Alternative Methods and Materials: If alternative methods and materials to those indicated are proposed for any phase of work, provide a written description including evidence of successful use on other, comparable projects, and program of testing to demonstrate effectiveness for use on this Project.~~

Fire-Prevention Plan: Prepare a written plan for preventing fires during the Work, including placement of fire extinguishers, fire blankets, rag buckets, and other fire-prevention devices during each phase or process. Coordinate plan with Owner's fire-protection equipment and requirements. Include fire watch personnel's training, duties, and authority to enforce fire safety.

SD-01 Preconstruction Submittals

~~Construction Schedule for Historic Treatment~~Historic Treatment Sub-schedule; G,RO
Photographic Documentation; G, RO
Historic Treatment Program; G, RO
Alternative Methods and Materials; G, RO
Fire-Prevention Plan; G, RO

SD-05 Design Data

Progress Photos; G, AE

1.7 QUALITY ASSURANCE

1.7.1 Historic Treatment Specialist Qualifications

An experienced firm regularly engaged in historic treatments similar in nature, materials, design, and extent to this work as specified in each section and that has completed a minimum of five recent projects with a record of successful in-service performance that demonstrates the firm's

qualifications to perform this work.

1. Field Supervisor Qualifications: Full-time supervisors experienced in historic treatment work similar in nature, material, design, and extent to that indicated for this Project. Supervisors shall be on Project site when historic treatment work begins and during its progress. Supervisors shall not be changed during Project except for causes beyond the control of the specialist firm.

    a. Construct new mockups of required work whenever a supervisor is replaced.

1.7.2 Historic Preservation Consultant Qualifications

A. Secure the services of a historic preservation consultant with a minimum of 10 years' experience applying NPS Hist Prop as they relate to the work in this section.

B. Submit a resume that describes five relevant projects within that period and include how NPS Hist Prop was applied to the work of similar scope and scale and what jurisdiction or agency was involved in approving the work.

C. The consultant's services include:

    1. Investigating the condition of the historic materials.
    2. Arranging for material analysis in the laboratory.
    3. Recommending appropriate repair, restoration, and cleaning materials and methods.
    4. Providing quality control services during construction.

1.7.3 Safety and Health Standard

Comply with ASSP A10.6.

1.8 STORAGE, AND HANDLING OF HISTORIC MATERIALS

1.8.1 Salvaged Historic Materials

1. Clean loose dirt and debris from salvaged historic items unless more extensive cleaning is indicated.
2. Pack or crate items after cleaning; cushion against damage during handling. Label contents of containers.
3. Store items in a secure area until delivery to Owner.
4. Transport items to Owner's storage area designated by Owner.
5. Protect items from damage during transport and storage.

1.8.2 Historic Materials for Reinstallation

1. Repair and clean historic items for reuse as indicated.
2. Pack or crate items after cleaning and repairing; cushion against damage during handling. Label contents of containers.
3. Protect items from damage during transport and storage.
4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment unless otherwise indicated. Provide connections, supports, and miscellaneous materials to make item functional for use indicated.

1.8.3 Existing Historic Materials to Remain

Protect construction indicated to remain against damage and soiling from construction work. Where permitted by Architect, items may be dismantled and taken to a suitable, protected storage location during construction work and reinstalled in their original locations after historic treatment and construction work in the vicinity is complete

1.8.4 Storage

Catalog and store historic items within a weathertight enclosure where they are protected from moisture, weather, condensation, and freezing temperatures.

1. Identify each item with a nonpermanent mark to document its original location. Indicate original locations on plans, elevations, sections, or photographs by annotating the identifying marks
2. Secure stored materials to protect from theft

1.8.5 Humidity

Control humidity so that it does not exceed 85 percent. Maintain temperatures 5 deg F (3 deg C) or more above the dew point

1.9 PROJECT/SITE CONDITIONS

1.9.1 Size Limitations in Historic Spaces

Materials, products, and equipment used for performing the Work and for transporting debris, materials, and products shall be of sizes that clear surfaces within historic spaces, areas, rooms, and openings, including temporary protection, by 12 inches (300 mm) or more.

1.10 Photographic Documentation:

1. Preconstruction Photos: Prior to start of work show existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by historic treatment operations.
2. Progress Photos: Provide Architect with progress photos documenting construction processes related to historic fabric. Photos shall be submitted on a bi-weekly basis or as construction procedures and progress dictate.

1.11 Alternative Methods and Materials

If alternative methods and materials to those indicated are proposed for any phase of work, provide a written description including evidence of successful use on other, comparable projects, and program of testing to demonstrate effectiveness for use on this Project.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.1 PROTECTION, GENERAL

Protect persons, surrounding surfaces of building and building site harm resulting from historic treatment procedures.

1. Use only proven protection methods, appropriate to each area and surface being protected.
2. Provide temporary barricades, barriers, and directional signage to exclude the public from areas where historic treatment work is being performed.
3. Erect temporary barriers to form and maintain fire-egress routes.
4. Erect temporary protective covers over walkways and at points of entrance and exit that must remain in service during historic treatment work.
5. Contain dust and debris generated by historic treatment work, and prevent it from reaching the public or adjacent surfaces.
6. Protect floors and other surfaces from work activities and along hauling routes from damage, wear, and staining.

3.1.1 Temporary Protection of Historic Materials

1. Protect existing historic materials with temporary protections and construction. Do not remove existing materials unless otherwise indicated.
2. Do not attach temporary protection to historic surfaces except as indicated as part of the historic treatment program and approved by Architect.

Comply with each product manufacturer's written instructions for protections and precautions. Protect against adverse effects of products and procedures on people and adjacent materials, components, and vegetation.

3.1.2 Utility and Communications Services

1. Notify Owner, Architect, authorities having jurisdiction, and entities owning or controlling wires, conduits, pipes, and other services affected by historic treatment work before commencing operations.
2. Disconnect and cap pipes and services as required by authorities having jurisdiction, as required for historic treatment work. Coordinate with Project Construction Manager.
3. Maintain existing services unless otherwise indicated; keep in service, and protect against damage during operations. Provide temporary services during interruptions to existing utilities.

3.2 PROTECTION FROM FIRE

3.2.1 General

Follow fire-prevention plan and the following:

1. Comply with NFPA 241 requirements unless otherwise indicated.
2. Remove and keep area free of combustibles, including rubbish, paper, waste, and chemicals, unless necessary for the immediate work.

    a. If combustible material cannot be removed, provide fire blankets to cover such materials.

3. Prohibit smoking by all persons within Project work and staging areas.

3.2.2 Combustible Materials

Comply with the following procedures while performing work with combustible solvents and chemicals are anticipated:

1. Fire Watch: Before working with heat-generating equipment or combustible materials, station personnel to serve as a fire watch at each location where such work is performed. Fire-watch personnel shall have the authority to enforce fire safety. Station fire watch according to NFPA 51B, NFPA 241.

3.2.3 Fire Extinguishers, Fire Blankets, and Rag Buckets

Maintain fire extinguishers, fire blankets, and rag buckets for disposal of rags with combustible liquids. Maintain each as suitable for the type of fire risk in each work area. Ensure that nearby personnel and the fire-watch personnel are trained in fire-extinguisher and blanket use.

3.2.4 Sprinklers

Where sprinkler protection exists and is functional, maintain it without interruption while operations are being performed. If operations are performed close to sprinklers, shield them temporarily with guards.

1. Remove temporary guards at the end of work shifts, whenever operations are paused, and when nearby work is completed.

3.3 PROTECTION DURING APPLICATION OF CHEMICALS

A. Protect all surrounding surfaces of areas being restored from harm or damage resulting from applications of chemicals and adhesives.

B. Cover adjacent surfaces with protective materials that are proved to resist chemicals selected for Project unless chemicals being used will not damage adjacent surfaces as indicated in historic treatment program. Use covering materials and masking agents that will not stain or leave residue on surfaces to which they are applied. Apply protective materials according to manufacturer's written instructions. Do not apply liquid masking agents or adhesives to painted or porous surfaces. When no longer needed, promptly remove protective materials.

C. Neutralize alkaline and acid wastes and legally dispose of off Owner's property.

D. Collect and dispose of runoff from chemical operations by legal means and in a manner that prevents soil contamination, damage to landscaping, or water penetration into building interior.

3.4 GENERAL HISTORIC TREATMENT

A. Work will be in keeping with NPS Hist Prop, "The Secretary of the Interior's Standards for the Treatment of Historic Properties with Guidelines for Preserving, Rehabilitating, Restoring & Reconstructing Historic Buildings."

B. Have historic treatment work performed only by qualified historic

treatment specialists.

C. Ensure that supervisory personnel are present when historic treatment work begins and during its progress.

D. Record existing work before each procedure (preconstruction), and record progress during the work. Use digital preconstruction documentation photograph or video recordings. Comply with requirements in Section 01 30 00 ADMINISTRATIVE REQUIREMENTS.

E. Perform surveys of Project Site as the Work progresses to detect hazards resulting from historic treatment procedures.

F. Follow the procedures in subparagraphs below and procedures approved in historic treatment program unless otherwise indicated:

1. Retain as much existing material as possible; repair and consolidate rather than replace.
2. Use reversible processes wherever possible.
3. Use historically accurate repair and replacement materials and techniques unless otherwise indicated.
4. Record existing work before each procedure (preconstruction) and progress during the work with digital preconstruction documentation photographs or video recordings. Comply with requirements in Section 01 30 00 ADMINISTRATIVE REQUIREMENTS.

G. Notify Architect of visible changes in the integrity of material or components.

1. Do not proceed with the work in question until directed by Architect.

H. Where missing features are indicated to be repaired or replaced, provide work with appearance based on accurate duplications rather than on conjecture, subject to approval of Architect.

I. Where work requires existing features to be removed or dismantled and reinstalled, perform these operations without damage to the material itself, to adjacent materials, or to the substrate.

J. Identify new and replacement materials and features with permanent marks hidden in the completed Work to distinguish them from original materials. Record a legend of identification marks and the locations of the items on record Drawings.

-- End of Section --

SECTION 01 78 00

CLOSEOUT SUBMITTALS
05/19

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 19005-3	(2012) Document Management -- Electronic Document File Format for Long-Term Preservation -- Part 3: Use of ISO 32000-1 with Support for Embedded Files (PDF/A-3)
ISO 32000-1	(2008) Document Management -- Portable Document Format -- Part 1: PDF 1.7

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 1110-1-2909	(2012) Geospatial Data and Systems
ERDC/ITL TR-12-1	(2015) A/E/C Graphics Standard, Release 2.0
ERDC/ITL TR-12-6	(2015) A/E/C CAD Standard - Release 6.0

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 1-300-08	(2009, with Change 2, 2011) Criteria for Transfer and Acceptance of DoD Real Property

1.2 DEFINITIONS

1.2.1 As-Built Drawings

As-built drawings are the marked-up drawings, maintained by the Contractor on-site, that depict actual conditions and deviations from the Contract Documents. These deviations and additions may result from coordination required by, but not limited to: contract modifications; official responses to submitted Requests for Information (RFI's); direction from the Contracting Officer; design that is the responsibility of the Contractor, and differing site conditions. Maintain the as-builts throughout construction as red-lined hard copies on site and red-lined PDF files. These files serve as the basis for the creation of the record drawings.

1.2.2 Record Drawings

The record drawings are the final compilation of actual conditions reflected in the as-built drawings.

Produce the record drawings from the Record Model(s) and do not include annotations indicating revisions.

1.2.3 Record Model

A model reflecting approved changes during construction including red-lines, requests for information (RFI's), and contract modifications. Include updated construction phase facility/site data for components.

1.2.4 Advanced Modeling

A subset of geospatial technologies as defined in EM 1110-1-2909 to include Building Information Modeling (BIM), Civil Information Modeling (CIM), Geographic Information Systems (GIS), and Computer-Aided Design (CAD). Advanced modeling is comprised of models and drawings that form a digital representation of the project, or part thereof, that are comprised of model elements with facility data.

1.2.5 USACE CAD/BIM Technology Center

The USACE CAD/BIM Technology Center hosts all standard content for USACE. This content can be accessed through the CAD/BIM Technology Center website, https://cadbimcenter.erdc.dren.mil/.

1.3 SOURCE DRAWING FILES

Request the full set of electronic drawings, in the source format, for Record Drawing preparation, after award and at least 30 days prior to required use.

1.3.1 Terms and Conditions

Data contained on these electronic files must not be used for any purpose other than as a convenience in the preparation of construction drawings and data for the referenced project. Any other use or reuse shall be at the sole risk of the Contractor and without liability or legal exposure to the Government. The Contractor must make no claim and waives to the fullest extent permitted by law, any claim or cause of action of any nature against the Government, its agents or sub consultants that may arise out of or in connection with the use of these electronic files. The Contractor must, to the fullest extent permitted by law, indemnify and hold the Government harmless against all damages, liabilities or costs, including reasonable attorney's fees and defense costs, arising out of or resulting from the use of these electronic files.

These electronic CAD drawing files are not construction documents. Differences may exist between the CAD files and the corresponding construction documents. The Government makes no representation regarding the accuracy or completeness of the electronic CAD files, nor does it make representation to the compatibility of these files with the Contractor hardware or software. In the event that a conflict arises between the signed and sealed construction documents prepared by the Government and the furnished Source drawing files, the signed and sealed construction documents govern. The Contractor is responsible for determining if any conflict exists. Use of these Source Drawing files does not relieve the Contractor of duty to fully comply with the contract documents, including and without limitation, the need to check, confirm and coordinate the work of all contractors for the project. If the Contractor uses, duplicates or modifies these electronic source drawing files for use in producing

construction drawings and data related to this contract, remove all previous indicia of ownership (seals, logos, signatures, initials and dates).

1.4 OWNERSHIP

The Government, for itself and such others as it deems appropriate, will have unlimited rights under this contract to all information and materials developed under this contract and furnished to the Government and documentation thereof, reports, and listings, and all other items pertaining to the work and services pursuant to this agreement including any copyright. Unlimited rights under this contract are rights to use, duplicate, or disclose text, data, drawings, and information, in whole or in part in any manner and for any purpose whatsoever without compensation to or approval from the Contractor. The Government will at all reasonable times have the right to inspect the work and will have access to and the right to make copies of the above-mentioned items. All text, electronic digital files, data, and other products generated under this contract shall become the property of the Government. By reference, the following DFAR clauses are included in this contract as a part of the requirements herein:

a. DFAR 252.227-7013, "Rights in Technical Data - Noncommercial Items."

b. DFAR 252.227-7017, "Identification and Assertion of Use, Release, or Disclosure Restrictions."

c. DFAR 252.227-7020, "Rights in Special Works."

d. DFAR 252.227-7028, "Technical Data or Computer Software Previously Delivered to the Government."

e. DFAR 252.227-7037, "Validation of Restrictive Markings on Technical Data."

f. DFAR 252.227-7025, "Limitations on the Use or Disclosure of Government-Furnished Information Marked with Restrictive Legends."

g. DFAR 252.227-7014, "Rights in Noncommercial Computer Software and Noncommercial Computer Software Documentation."

1.5 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Warranty Management Plan

Warranty Tags

Spare Parts Data

SD-08 Manufacturer's Instructions

Posted Instructions

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals; G, RO

SD-11 Closeout Submittals

As-Built Drawings; G, RO

Record Drawings; G, RO

Record Model; G, RO

As-Built Record of Equipment and Materials

Final Approved Shop Drawings; G, RO

Construction Contract Specifications; G, RO

Certification of EPA Designated Items; G, RO

Certification Of USDA Designated Items; G, RO

Interim DD FORM 1354; G, RO

Checklist for DD FORM 1354; G, RO

High Performance And Sustainable Building (HPSB) Checklist; G, RO

1.6 SPARE PARTS DATA

Submit three copies of the Spare Parts Data list. Also, electronically in PDF format, via email.

a. Indicate manufacturer's name, part number, and stock level required for test and balance, pre-commissioning, maintenance and repair activities. List those items that may be standard to the normal maintenance of the system.

b. At acceptance of commissioning, ensure the required stock level is supplied as indicated in subparagraph a for maintenance and repair activities through the facilities warranty period. Provision of spare parts does not relieve the Contractor of responsibilities listed under the contract guarantee provisions.

1.7 QUALITY CONTROL

Additions and corrections to the contract drawings must be equal in quality and detail to that of the originals. Line colors, line weights, lettering, layering conventions, and symbols must be the same as the original line colors, line weights, lettering, layering conventions, and symbols.

1.8 WARRANTY MANAGEMENT

1.8.1 Warranty Management Plan

Develop a warranty management plan, which contains information relevant to FAR 52.246-21 Warranty of Construction. At least 30 days before the planned pre-warranty conference, submit electronically and three hard copies of the warranty management plan. Include within the warranty management plan all required actions and documents to assure that the Government receives all warranties to which it is entitled. The plan narrative must contain sufficient detail to render it suitable for use by future maintenance and repair personnel, whether tradesmen, or of engineering background, not necessarily familiar with this contract. The term "status" as indicated below must include due date and whether item has been submitted or was accomplished. Submit warranty information, made available during the construction phase, to the Contracting Officer for approval prior to each monthly pay estimate. Assemble approved information in a binder and turn over to the Government upon acceptance of the work. The construction warranty period must begin on the date of project acceptance and continue for the full product warranty period. Conduct a joint 4 month and 9 month warranty inspection, measured from time of acceptance; with the Contractor, Contracting Officer and the Customer Representative. The warranty management plan must include, but is not limited to, the following:

a. Roles and responsibilities of personnel associated with the warranty process, including points of contact and telephone numbers within the organizations of the Contractors, subcontractors, manufacturers or suppliers involved.

b. For each warranty, the name, address, telephone number, and e-mail of each of the guarantor's representatives nearest to the project location.

c. A list and status of delivery of Certificates of Warranty for extended warranty items, including roofs, HVAC balancing, pumps, motors, transformers, and for commissioned systems, such as fire protection and alarm systems, sprinkler systems, and lightning protection systems.

d. As-Built Record of Equipment and Materials list for each warranted equipment, item, feature of construction or system indicating:

(1) Name of item.
(2) Model and serial numbers.
(3) Location where installed.
(4) Name and phone numbers of manufacturers or suppliers.
(5) Names, addresses and telephone numbers of sources of spare parts.
(6) Warranties and terms of warranty. Include one-year overall warranty of construction, including the starting date of warranty of construction. Items which have warranties longer than one year must be indicated with separate warranty expiration dates.
(7) Cross-reference to warranty certificates as applicable.
(8) Starting point and duration of warranty period.
(9) Summary of maintenance procedures required to continue the warranty in force.
(10) Cross-reference to specific pertinent Operation and Maintenance manuals.
(11) Organization, names and phone numbers of persons to call for warranty service.

(12) Typical response time and repair time expected for various warranted equipment.

e. The plans for attendance at the 4 and 9 month post-construction warranty inspections conducted by the Government.

f. Procedure and status of tagging of equipment covered by warranties longer than one year.

g. Copies of instructions to be posted near selected pieces of equipment where operation is critical for warranty or safety reasons.

1.8.2 Performance Bond

The Performance Bond must remain effective throughout the construction and warranty period .

a. In the event the Contractor fails to commence and diligently pursue any construction warranty work required, the Contracting Officer will have the work performed by others, and after completion of the work, will charge the remaining construction warranty funds of expenses incurred by the Government while performing the work, including, but not limited to administrative expenses.

b. In the event sufficient funds are not available to cover the construction warranty work performed by the Government at the Contractor's expense, the Contracting Officer will have the right to recoup expenses from the bonding company.

c. Following oral or written notification of required construction warranty repair work, respond in a timely manner. Written verification will follow oral instructions. Failure to respond will be cause for the Contracting Officer to proceed against the Contractor.

1.8.3 Pre-Warranty Conference

Prior to contract completion, and at a time designated by the Contracting Officer, meet with the Contracting Officer to develop a mutual understanding with respect to the requirements of this section. At this meeting, establish and review communication procedures for Contractor notification of construction warranty defects, priorities with respect to the type of defect, reasonable time required for Contractor response, and other details deemed necessary by the Contracting Officer for the execution of the construction warranty In connection with these requirements and at the time of the Contractor's quality control completion inspection, furnish the name, telephone number and address of a licensed and bonded company which is authorized to initiate and pursue construction warranty work action on behalf of the Contractor. This point of contact must be located within the local service area of the warranted construction, be continuously available, and be responsive to Government inquiry on warranty work action and status. This requirement does not relieve the Contractor of any of its responsibilities in connection with other portions of this provision.

1.8.4 Contractor's Response to Construction Warranty Service Requirements

Following oral or written notification by the Contracting Officer, respond to construction warranty service requirements in accordance with the "Construction Warranty Service Priority List" and the three categories of

priorities listed below. Submit a report on any warranty item that has been repaired during the warranty period. Include within the report the cause of the problem, date reported, corrective action taken, and when the repair was completed. If the Contractor does not perform the construction warranty within the timeframe specified, the Government will perform the work and back charge the construction warranty payment item established.

a. First Priority Code 1. Perform onsite inspection to evaluate situation, and determine course of action within 4 hours, initiate work within 6 hours and work continuously to completion or relief.

b. Second Priority Code 2. Perform onsite inspection to evaluate situation, and determine course of action within 8 hours, initiate work within 24 hours and work continuously to completion or relief.

c. Third Priority Code 3. All other work to be initiated within 3 work days and work continuously to completion or relief.

d. The "Construction Warranty Service Priority List" is as follows:

Code 1-Life Safety Systems
(1) Fire suppression systems.
(2) Fire alarm system(s) in place in the building.

Code 1-Air Conditioning Systems
(1) Recreational support.
(2) Air conditioning leak in part of building, if causing damage.
(3) Air conditioning system not cooling properly.

Code 1-Doors
(1) Overhead doors not operational, causing a security, fire, or safety problem.
(2) Interior, exterior personnel doors or hardware, not functioning properly, causing a security, fire, or safety problem.

Code 3-Doors
(1) Overhead doors not operational.
(2) Interior/exterior personnel doors or hardware not functioning properly.

Code 1-Electrical
(1) Power failure (entire area or any building operational after 1600 hours).
(2) Security lights
(3) Smoke detectors

Code 2-Electrical
(1) Power failure (no power to a room or part of building).
(2) Receptacle and lights (in a room or part of building).

Code 3-Electrical
Street lights.

Code 1-Gas
(1) Leaks and breaks.
(2) No gas to family housing unit or cantonment area.

Code 1-Heat
(1) Area power failure affecting heat.

(2) Heater in unit not working.

Code 2-Kitchen Equipment
(1) Dishwasher not operating properly.
(2) All other equipment hampering preparation of a meal.

Code 1-Plumbing
(1) Hot water heater failure.
(2) Leaking water supply pipes.

Code 2-Plumbing
(1) Flush valves not operating properly.
(2) Fixture drain, supply line to commode, or any water pipe leaking.
(3) Commode leaking at base.

Code 3 -Plumbing
Leaky faucets.

Code 3-Interior
(1) Floors damaged.
(2) Paint chipping or peeling.
(3) Casework.

Code 1-Roof Leaks
Temporary repairs will be made where major damage to property is occurring.

Code 2-Roof Leaks
Where major damage to property is not occurring, check for location of leak during rain and complete repairs on a Code 2 basis.

Code 2-Water (Exterior)
No water to facility.

Code 2-Water (Hot)
No hot water in portion of building listed.

Code 3-All other work not listed above.

1.8.5 Warranty Tags

At the time of installation, tag each warranted item with a durable, oil and water resistant tag approved by the Contracting Officer. Attach each tag with a copper wire and spray with a silicone waterproof coating. Also, submit two record copies of the warranty tags showing the layout and design. The date of acceptance and the QC signature must remain blank until the project is accepted for beneficial occupancy. Show the following information on the tag.

Type of product/material	
Model number	
Serial number	

Contract number	
Warranty period from/to	
Inspector's signature	
Construction Contractor	
Address	
Telephone number	
Warranty contact	
Address	
Telephone number	
Warranty response time priority code	
WARNING - PROJECT PERSONNEL TO PERFORM ONLY OPERATIONAL MAINTENANCE DURING THE WARRANTY PERIOD.	

PART 2 PRODUCTS

2.1 RECORD DRAWINGS

Prepare the CAD drawing files in AutoCAD Release 2018 format compatible with a Windows 10 operating system.

2.1.1 Additional Drawings

If additional drawings are required, prepare them using the specified electronic file format applying the same graphic standards specified for original drawings. The title block and drawing border to be used for any new final record drawings must be identical to that used on the contract drawings.

2.1.1.1 Sheet Numbers and File Names

If a sheet needs to be added between two sequential sheets, append a Supplemental Drawing Designator in accordance with ERDC/ITL TR-12-6 Adding a drawing sheet, and ERDC/ITL TR-12-1 Adding or deleting drawing sheets and index sheet procedures.

2.2 ADVANCED MODELING PACKAGE

For each Advanced Modeling Package submittal for both the Interim Record Model Package and the Final Record Model Package, submit in accordance with ERDC/ITL TR-12-6 and also provide the following items:

a. Advanced Modeling PxP: Provide an electronic copy of the most current

approved version of the project Advanced Modeling PxP.

b. Electronic Files: Provide an electronic list (.txt file or similar), of all submitted electronic files including a description, directory, and file name for each file submitted. Identify which files have been produced from the Model and Facility Data. For all sheet files, include a list of the sheet titles and sheet numbers.

c. Advanced Modeling Submittal Checklist: Complete the USACE BIM/CIM Advanced Modeling Submittal Checklist and include with each submittal. Download the Checklist from the USACE CAD/BIM Technology Center website.

d. Advanced Modeling Files: Provide all native Advanced Modeling files associated with the production of the contract drawings and associated as-modeled drawings. Update and maintain in compliance with the Advanced Modeling formatting, content requirement, and standards in, in order to yield a complete and coordinated document package.

e. Quality Control (QC) Reports: Provide electronic PDFs of all QC reports and checklist utilized to ensure full compliance with the contract requirements and standards.

f. CAD Exports of BIM-Generated Sheets and Drawings: Provide supplemental 2D CAD exports from the project BIM model as needed to demonstrate compliance with contract requirements.

2.3 CERTIFICATION OF EPA DESIGNATED ITEMS

Submit the Certification of EPA Designated Items as required by FAR 52.223-9 Estimate of Percentage of Recovered Material Content for EPA Designated Items and FAR 52-223-17 Affirmative Procurement of EPA designated items in Service and Construction Contracts.. Include on the certification form the following information: project name, project number, Contractor name, license number, Contractor address, and certification. The certification will read as follows and be signed and dated by the Contractor. "I hereby certify the information provided herein is accurate and that the requisition/procurement of all materials listed on this form comply with current EPA standards for recycled/recovered materials content. The following exemptions may apply to the non-procurement of recycled/recovered content materials:

1) The product does not meet appropriate performance standards;
2) The product is not available within a reasonable time frame;
3) The product is not available competitively (from two or more sources);
4) The product is only available at an unreasonable price (compared with a comparable non-recycled content product)."

Record each product used in the project that has a requirement or option of containing recycled content in accordance with SECTION 01 33 29 SUSTAINABILITY REPORTING, noting total price, total value of post-industrial recycled content, total value of post-consumer recycled content, exemptions (1, 2, 3, or 4, as indicated), and comments. Recycled content values may be determined by weight or volume percent, but must be consistent throughout.

2.4 CERTIFICATION OF USDA DESIGNATED ITEMS

Submit the Certification of USDA Designated Items as required by FAR

52-223-1 Bio-based Product Certifications and FAR 52.223-2 Affirmative Procurement of Biobased Products Under Service and Construction Contracts. Include on the certification form the following information: project name, project number, Contractor name, license number, Contractor address, and certification. The certification will read as follows and be signed and dated by the Contractor. "I hereby certify the information provided herein is accurate and that the requisition/procurement of all materials listed on this form comply with current USDA standards for biobased materials content. The following exemptions may apply to the non-procurement of biobased content materials:

1) The product does not meet appropriate performance standards;
2) The product is not available within a reasonable time frame;
3) The product is not available competitively (from two or more sources);
4) The product is only available at an unreasonable price (compared with a comparable bio-based content product)."

Record each product used in the project that has a requirement or option of containing biobased content in accordance with SECTION 01 33 29 SUSTAINABILITY REPORTING, noting total price, total value of post-industrial recycled content, total value of post-consumer recycled content, total value of biobased content, exemptions (1, 2, 3, or 4, as indicated), and comments. Biobased content values may be determined by weight or volume percent, but must be consistent throughout.

2.5 PDF AS-BUILT FILES

Provide electronic PDF "plots" of all contract drawings sheets associated with the as-built drawing submittal. Compile and organize the PDF set to match the contract drawings. Bookmark and label the pages of the PDF file.

2.5.1 PDF File Packaging

Utilize PDF file format in accordance with ISO 32000-1 and ISO 19005-3. Provide files from original sources, text-searchable, and saved in "Standard" (uncompressed) resolution whenever possible.

2.5.1.1 Bookmarking

a. Bookmark drawing submittal PDF sets to include one Parent Bookmark per Discipline and one Child Bookmark per sheet within each Discipline. Format Parent Bookmarks as "Discipline" (e.g. Architectural). Format Child Bookmarks as "Sheet ID Sheet Title" (e.g. A-101 First Floor Plan).

b. Bookmark specification submittal PDF sets using the SpecsIntact Print Processing PDF Print/Publish feature, combining processed sections into one PDF document. Insert the Submittal Register into the file where specified by Section 01 33 00 SUBMITTAL PROCEDURES and bookmark.

2.5.1.2 Hyperlinking

Hyperlink all reference annotation symbology (e.g. section cut symbology, detail callout symbology, elevation callout symbology) to the sheet referenced by the annotation.

2.6 REDLINES AND MARKUPS

Provide PDFs of the current working redlines and/or markups complying with

the as-builts drawing and markup requirements contained in this specification.

2.7 AS-BUILT OR ADVANCED MODELING RE-SUBMISSION REQUIREMENTS

If elements of an as-built submittal or advanced modeling package are rejected, provide the following for each re-submission, in addition to any information required in Section 01 33 00 SUBMITTAL PROCEDURES:

a. Re-submit all components required under paragraph As-Builts or Advanced Modeling Package, including a new Advanced Modeling Submittal Checklist and updated content in response to Government comments.

b. Provide a copy of all Government review comments.

c. Provide a disposition/response to each Government review comment for a back-check of the re-submission deliverable.

PART 3 EXECUTION

3.1 AS-BUILT DRAWINGS

Provide and maintain two black line print copies of the PDF contract drawings for As-Built Drawings. Maintain the as-builts throughout construction as red-lined hard copies on site and red-lined PDF files. Submit As-Built Drawings 30 days prior to Beneficial Occupancy Date (BOD).

3.1.1 Markup Guidelines

Make comments and markup the drawings complete without reference to letters, memos, or materials that are not part of the As-Built drawing. Show what was changed, how it was changed, where item(s) were relocated and change related details. These working as-built markup prints must be neat, legible and accurate as follows:

a. Use base colors of red, green, and blue. Color code for changes as follows:

(1) Special (Blue) - Items requiring special information, coordination, or special detailing or detailing notes.

(2) Deletions (Red) - Over-strike deleted graphic items (lines), lettering in notes and leaders.

(3) Additions (Green) - Added items, lettering in notes and leaders.

b. Provide a legend if colors other than the "base" colors of red, green, and blue are used.

c. Add and denote any additional equipment or material facilities, service lines, incorporated under As-Built Revisions if not already shown in legend.

d. Use frequent written explanations on markup drawings to describe changes. Do not totally rely on graphic means to convey the revision.

e. Use legible lettering and precise and clear digital values when marking prints and PDF files. Clarify ambiguities concerning the nature and application of change involved.

f. Wherever a revision is made, also make changes to related section views, details, legend, profiles, plans and elevation views, schedules, notes and call out designations, and mark accordingly to avoid conflicting data on all other sheets.

g. For deletions, cross out all features, data and captions that relate to that revision.

h. For changes on small-scale drawings and in restricted areas, provide large-scale inserts, with leaders to the applicable location.

i. Indicate one of the following when attaching a print or sketch to a markup print:

1) Add an entire drawing to contract drawings

2) Change the contract drawing to show

3) Provided for reference only to further detail the initial design.

j. Incorporate all shop and fabrication drawings into the markup drawings.

3.1.2 As-Built Drawings Content

Revise As-Built Drawings in accordance with ERDC/ITL TR-12-1. Keep these working as-built markup drawings current on a weekly basis and at least one set available on the jobsite at all times. Changes from the contract drawings which are made during construction or additional information which might be uncovered in the course of construction must be accurately and neatly recorded as they occur by means of details and notes. Submit the working as-built markup drawings for approval prior to submission of each monthly pay estimate. For failure to maintain the working and final record drawings as specified herein, the Contracting Officer will withhold 10 percent of the monthly progress payment until approval of updated drawings. Show on the as-built drawings, but not limited to, the following information:

a. The actual location, kinds and sizes of all sub-surface utility lines. In order that the location of these lines and appurtenances may be determined in the event the surface openings or indicators become covered over or obscured, show by offset dimensions to two permanently fixed surface features the end of each run including each change in direction on the record drawings. Locate valves, splice boxes and similar appurtenances by dimensioning along the utility run from a reference point. Also record the average depth below the surface of each run.

b. The location and dimensions of any changes within the building structure.

c. Layout and schematic drawings of electrical circuits and piping.

d. Correct grade, elevations, cross section, or alignment of roads, earthwork, structures or utilities if any changes were made from contract plans.

e. Changes in details of design or additional information obtained from working drawings specified to be prepared or furnished by the

Contractor; including but not limited to shop drawings, fabrication, erection, installation plans and placing details, pipe sizes, insulation material, dimensions of equipment, and foundations.

f. The topography, invert elevations and grades of drainage installed or affected as part of the project construction.

g. Changes or Revisions which result from the final inspection.

h. Where contract drawings or specifications present options, show only the option selected for construction on the working as-built markup drawings.

i. If borrow material for this project is from sources on Government property, or if Government property is used as a spoil area, furnish a contour map of the final borrow pit/spoil area elevations.

j. Systems designed or enhanced by the Contractor, such as HVAC controls, fire alarm, fire sprinkler, and irrigation systems.

k. Changes in location of equipment and architectural features.

l. Modifications.

m. Actual location of anchors, construction and control joints, etc., in concrete.

n. Unusual or uncharted obstructions that are encountered in the contract work area during construction.

o. Location, extent, thickness, and size of stone protection particularly where it will be normally submerged by water.

p. Installed manufacturer information: Manufacturer information shall include Manufacturer Name, Model, Serial Number as applicable based on elements already modeled in final design BIM model. See "USAG WEST POINT - NEW EQUIPMENT INVENTORY" table, in this section, for the complete list of information that must be provided.

-Architecture: Windows, Doors and related Hardware, Reflected Ceiling, Manufactured Casework, Restroom Partitions and Accessories (Architecture Models)

-Mechanical: Scheduled Equipment (Mechanical Models)

-Plumbing: Scheduled Equipment (Plumbing Models); Restroom/Kitchen Fixtures: Sinks, Faucets, Toilets, Shower Equipment: Drinking Fountains (Plumbing/Mechanical Models)

-Electrical: Power (generator / UPS / unit substation / transformers / switchboards /overcurrent protection devices) - Lighting (occupancy sensors / fixtures) - Fire Alarm (entire system minus cabling - all devices and panels) - Access Control (card readers / control panels / power supplies / access control door hardware) - Telecommunications (racks / patch panels / 110 blocks / jacks)

-Fire Protection: Mains and Standpipes 2" inches or greater, fire pumps and other scheduled equipment.

-Lab Equipment: Scheduled Equipment - Group I Equipment (Spec 11 53 00), Piping valves, Laboratory service fittings and emergency fixtures; Custom Built Lab Furnishings Manufacturer (Lab Models: Equipment & Plumbing)

3.2 RECORD DRAWING FILES

If additional drawings are required, prepare them using the specified electronic file format applying the same graphic standards specified for original drawings. The title block and drawing border to be used for any new final record drawings must be identical to that used on the contract drawings. Accomplish additions and corrections to the contract drawings using CAD files. Provide all program files and hardware necessary to prepare final PDF record drawings. The Contracting Officer will review final PDF record drawings for accuracy and return them to the Contractor for required corrections, changes, additions, and deletions.

3.2.1 Rename the CAD Drawing files

Rename the CAD Drawing files using the contract number as the Project Code field,(e.g., W91238-15-C-10A-102.DWG) as instructed in the Pre-Construction conference. Use only those renamed files for the Marked-up changes. Make all changes on the layer/level as the original item.

a. For AutoCAD files (DWG), enter all as-built delta changes and notations on the AS-BUILT layer.

c. When final revisions have been completed, show the wording "RECORD DRAWING AS-BUILTS" followed by the name of the Contractor in letters at least 3/16 inch high on the cover sheet drawing. Date RECORD DRAWING AS-BUILTS" drawing revisions in the revision block.

d. Within 20 days after Government approval of all of the working record drawings for a phase of work, prepare the final CAD record drawings for that phase of work and submit PDF drawing files and two sets of prints for review and approval. The Government will promptly return one set of prints and PDF files annotated with any necessary corrections. Within 10 days revise the CAD files accordingly at no additional cost and submit one set of final prints and PDF files for the completed phase of work to the Government. Within 20 days of substantial completion of all phases of work, submit the final record drawing package for the entire project. Submit one set of electronic CAD files, and one set of the approved working record PDF files on five optical discs, two sets of full size prints, and, via email in PDF format. The CAD files must be complete in all details and identical in form and function to the CAD drawing files supplied by the Government. Prepare AutoCAD files for transmittal using e-Transmit. Make any transactions or adjustments necessary to accomplish this. The Government reserves the right to reject any drawing files it deems incompatible with the customer's CAD system. Paper prints, drawing files and storage media submitted will become the property of the Government upon final approval. Failure to submit final record PDF drawing files, CAD files and marked prints as specified will be cause for withholding any payment due under this contract. Approval and acceptance of final record drawings must be accomplished before final payment is made.

3.3 RECORD DRAWINGS

Prepare final record drawings after the completion of each definable feature of work as listed in the Contractor Quality Control Plan (such as Foundations, Utilities, or Structural Steel as appropriate for the project). Transfer the changes from the approved working as-built markup drawings to the original electronic CAD drawing files. Modify the as-built CAD drawing files to correctly show the features of the project as-built by bringing the working CAD drawing set into agreement with approved working as-built markup drawings, and adding such additional drawings as may be necessary. Refer to ERDC/ITL TR-12-1. Jointly review the working as-built markup drawings with printouts from working as-built CAD drawing PDF files for accuracy and completeness. Monthly review of working as-built CAD drawing PDF file printouts must cover all sheets revised since the previous review. These PDF drawing files are part of the permanent records of this project. Any drawings damaged or lost must be satisfactorily replaced at no expense to the Government.

Drawing revisions (include within change order price the cost to change working and final record drawings to reflect revisions) and compliance with the following procedures.

a. Follow directions in the revision for posting descriptive changes.

b. The revision delta size must be 5/16 inch unless the area where the delta is to be placed is crowded. Use a smaller size delta for crowded areas.

c. Place a revision delta at the location of each deletion.

d. For new details or sections which are added to a drawing, place a revision delta by the detail or section title.

e. For minor changes, place a revision delta by the area changed on the drawing (each location).

f. For major changes to a drawing, place a revision delta by the title of the affected plan, section, or detail at each location.

g. For changes to schedules or drawings, place a revision delta either by the schedule heading or by the change in the schedule.

3.3.1 Final Record Drawing Package

Submit the final record PDF and CAD drawings package for the entire project within 20 days of substantial completion of all phases of work. Submit five sets of ANSI D size PDF and CAD files on optical disc, read-only memory (ROM), two sets of ANSI D size prints and one set of the approved working record drawings. The package must be complete in all details and identical in form and function to the contract drawing files supplied by the Government.

3.4 FINAL APPROVED SHOP DRAWINGS

Submit final approved project shop drawings 30 days after transfer of the completed facility.

3.5 CONSTRUCTION CONTRACT SPECIFICATIONS

Submit final PDF file record construction contract specifications, including revisions thereto, 30 days after transfer of the completed facility. Failure to submit final record PDF specification files, PDF files as specified will be cause for withholding payment due under this contract. Approval and acceptance of final record construction contract specifications must be accomplished before final payment is made.

3.6 AS-BUILT RECORD OF MATERIALS

Furnish electronically in PDF format, via email the preliminary record of equipment and materials used on the project 15 days prior to final inspection. This preliminary submittal will be reviewed and returned 2 days after final inspection with Government comments. Submit Two sets of final record of equipment and materials 10 days after final inspection. Key the designations to the related area depicted on the contract drawings. Contractor is required to complete and submit the DPW Equipment Inventory Spreadsheet with the final as-builts. See attached spreadsheet.

RECORD OF DESIGNATED MATERIALS DATA				
Description	Specification Section	Manufacturer and Catalog, Model, and Serial Number	Composition and Size	Where Used

3.7 OPERATION AND MAINTENANCE MANUALS

Provide project operation and maintenance manuals as specified in Section 01 78 23 OPERATION AND MAINTENANCE MANUALS DATA. Provide four electronic copies of the Operation and Maintenance Manual files and three hard copy of the Operation and Maintenance Manuals. Submit to the Contracting Officer for approval within 30 calendar days of the Beneficial Occupancy Date (BOD). Update and resubmit files for final approval at BOD.

3.8 CLEANUP

Leave premises "broom clean." Clean interior and exterior glass surfaces exposed to view; remove temporary labels, stains and foreign substances; polish transparent and glossy surfaces; vacuum carpeted and soft surfaces. Clean equipment and fixtures to a sanitary condition. Replace filters of operating equipment. Clean debris from roofs, gutters, downspouts and drainage systems. Sweep paved areas and rake clean landscaped areas. Remove waste and surplus materials, rubbish and construction facilities from the site..

3.9 REAL PROPERTY RECORD

Refer to UFC 1-300-08 for instruction on completing the DD FORM 1354. Contact the Contracting Officer for any project specific information necessary to complete the DD FORM 1354.

3.9.1 Interim DD FORM 1354

Near the completion of Project, but a minimum of 60 days prior to final acceptance of the work, complete, update draft DD FORM 1354 attached to this section, and submit an accounting of all installed property with Interim DD FORM 1354. Include any additional assets, improvements, and alterations from the Draft DD FORM 1354.

3.9.2 Completed DD FORM 1354

Attach the Real Property receiving Component's completed High Performance and Sustainable Building (HPSB) Checklist for each applicable building to the completed DD 1354, in accordance with Section 01 33 29 SUSTAINABILITY REPORTING. For convenience, a blank fillable PDF DD FORM 1354 may be obtained at the following link:
www.esd.whs.mil/Portals/54/Documents/DD/forms/dd/dd1354.pdf

Submit the completed Checklist for DD FORM 1354 of Installed Building Equipment items. Attach this list to the updated DD FORM 1354.

~~3.10 FINAL ACCEPTANCE~~

~~Failure to make an acceptable submission of Record Drawings will delay the Final Acceptance Inspection for the project and shall be cause for withholding any payment due the Contractor under this contract.~~

3.10 PROPERTY

Paper prints, reproducible drawings and CAD files will become property of the Government upon final approval. Approval and acceptance of the final record drawings must be accomplished before final payment is made to the Contractor.

3.11 PAYMENT

No separate payment will be made for the as-built and record drawings or updating of CAD files required under this contract, and all costs in connection therewith shall be considered a subsidiary obligation of the Contractor.

-- End of Section --

SECTION 01 91 00.15 10

TOTAL BUILDING COMMISSIONING
05/19

PART 1 GENERAL

1.1 SUMMARY

Commission the building systems listed herein. Employ the services of an independent Commissioning Firm. The Commissioning Firm must be a 1st tier subcontractor of the General or Prime Contractor and must be financially and corporately independent of all other subcontractors. The Commissioning Firm must employ a Lead Commissioning Specialist that coordinates all aspects of the commissioning process. Conform to the commissioning procedures outlined in this specification.

1.2 SYSTEMS TO BE COMMISSIONED

Commission the following systems:

Heating, Ventilating, Air Conditioning, and Refrigeration Systems (HVAC)
Building Automation System
Utility Monitoring and Control System
Lighting Systems
Power Distribution Systems
Power Generation Systems
Plumbing Systems
Natural Gas and Propane Systems
Energy and Water Utility Metering Systems and Sub-Meters
Building Envelope: include moisture, thermal integrity, and air tightness for the entire buidling envelope including systems such as walls, fenestration, roofing, below grade perimeter walls.

1.3 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 180	(2012) Standard Practice for Inspection and Maintenance of Commercial Building HVAC Systems
ASHRAE 202	(2013; Addenda B 2018) Commissioning Process for Buildings and Systems

ASSOCIATED AIR BALANCE COUNCIL (AABC)

ACG Commissioning Guideline	(2005) Commissioning Guideline

NATIONAL ENVIRONMENTAL BALANCING BUREAU (NEBB)

NEBB Commissioning Standard	(2009) Procedural Standards for Whole Building Systems Commissioning of New Construction; 3rd Edition

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1429	(1994) HVAC Systems Commissioning Manual, 1st Edition

U.S. ARMY CORPS OF ENGINEERS (USACE)

ER 25-345-1	(1991) Systems Operation and Maintenance Documentation

1.4 COMMUNICATION WITH THE GOVERNMENT

The Lead Commissioning Specialist (CxC) must submit all plans, schedules, reports, and documentation directly to the Contracting Officer Representative concurrent with submission to the CQC System Manager. The Lead Commissioning Specialist must have direct communication with the Contracting Officer's Representative regarding all elements of the commissioning process; however, the Government has no direct contract authority with the Lead Commissioning Specialist.

1.5 SEQUENCING AND SCHEDULING

1.5.1 Sequencing

Complete the following prior to starting Functional Performance Tests of mechanical systems:

a. All equipment and systems have been completed, cleaned, flushed, disinfected, calibrated, tested, and operate in accordance with contract documents and construction plans and specifications.

b. Performance Verification Tests of the controls systems have been completed and the Performance Verification Test Report has been submitted and approved in accordance with Specification Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

c. Testing, Adjusting, and Balancing has been completed and the Testing, Adjusting, and Balancing Report, has been submitted and approved in accordance with Specification Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC.

d. The building envelope is enclosed according to contract documents with final construction completed, the Air Leakage Tests have been completed and the Air Leakage Test Reports and Diagnostic Test Reports have been submitted and approved in accordance with Specification Sections 08 39 54 EXTERIOR DOORS and 08 51 13 ALUMINUM WINDOWS.

e. The Pre-Functional Checklists have been submitted and approved.

f. The Certificate of Readiness for mechanical systems has been submitted and approved.

Complete the following prior to starting Functional Performance Tests of the electrical systems:

a. All electrical, power generation, and lighting equipment and systems have been completed, calibrated, tested, and operate in accordance with contract documents and construction plans and specifications.

b. The building envelope is enclosed according to contract documents with final construction completed.

c. Ceiling tiles, floor coverings, and window coverings are in place.

d. The Certificate of Readiness for electrical systems has been submitted and approved.

e. Lamps have completed a minimum 100 hour burn-in period.

f. Occupancy schedules set and integration between lighting systems and HVAC systems complete.

1.5.2 Project Schedule

Include the following tasks in the project schedule required by Section 01 32 01.00 10 PROJECT SCHEDULE. Ensure sufficient time is scheduled to accommodate the requirements of this specification section. The order of items listed below is not intended to imply a specified sequence:

a. Submission and approval of the Commissioning Firm and Commissioning Specialist

b. Submission and approval of the Testing, Adjusting, and Balancing (TAB) Firm and TAB Specialist specified in Specification Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC

c. Submission of the Design Review Report specified herein.

d. Submission of the Design Review Report specified in Specification Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC.

e. Submission and approval of the Construction Phase Commissioning Plan

f. Installation of permanent utilities (gas, water, electric)

g. Building Envelope Construction

h. Submission and approval of the Building Envelope Inspection Checklists

i. Drainage and Vent, Building Sewers, Water Supply Systems and Backflow Prevention Assembly Tests specified in Specification Section 22 00 00 PLUMBING, GENERAL PURPOSE

j. Factory Acceptance Testing for each of the systems to be commissioned as required by technical specifications

k. Manufacturer's Equipment Start-Up for each of the systems to be commissioned.

l. Potable Water System Flushing specified in Specification Section 22 00 00 PLUMBING, GENERAL PURPOSE

m. Operational Tests of the plumbing system specified in Specification Section 22 00 00 PLUMBING, GENERAL PURPOSE.

n. Potable Water System Disinfection specified in Specification Section 22 00 00 PLUMBING, GENERAL PURPOSE

o. Submission and approval of the TAB Schematic Drawings, Report Forms, and Procedures specified in Specification Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC.

p. Submission and approval of Duct Air Leakage Test Procedures specified in Specification Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC

q. Duct Air Leakage Test Execution specified in Specification Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC

r. Submission and approval of the Final Duct Air Leakage Test Report specified in Specification Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC

s. Testing, Adjusting, and Balancing (TAB) Field Work required by Specification Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC

t. Submission and approval of the TAB Report specified in Specification Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC

u. TAB Field Acceptance Testing required by Specification Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC

v. Submission and approval of the Start-Up Testing Report specified in Specification Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

w. Submission and approval of the Performance Verification Test Procedures specified in Specification Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

x. Performance Verification Tests required by Specification Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC

y. Performance Verification Test Report specified in Specification Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC

z. Performance Verification Tests required by Specification Section 25 10 10 UTILITY MONITORING AND CONTROL SYSTEM (UMCS) FRONT END INTEGRATION.

aa. Performance Verification Test Reports required by Specification Section 25 10 10 UTILITY MONITORING AND CONTROL SYSTEM (UMCS) FRONT END INTEGRATION.

aa. bbre-Functional Checklist Submittal

cc. Functional Performance Testing for each system to be commissioned

cc. Integrated Systems Tests

ee. Post-Test Deficiency Correction for each system to be commissioned

ff. Re-Testing

gg. Training for each of the systems to be commissioned

hh. Systems Manual, Maintenance Plan, and Service Life Plan submission and approval

ii. Submission and approval of the Commissioning Report

jj. Seasonal Testing

kk. Post-Construction Endurance Testing

ll. Post-Construction Site Visit

1.6 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Commissioning Firm; G, DO

Lead Commissioning Specialist; G, DO

Technical Commissioning Specialists; G, DO

Commissioning Firm's Contract; G, DO

SD-06 Test Reports

Design Review Report; G, DO

Interim Construction Phase Commissioning Plan; G, DO

Final Construction Phase Commissioning Plan; G, DO

Template Building Envelope Inspection Checklists; G, DO

Building Envelope Inspection Checklists; G, DO

Pre-Functional Checklists; G, DO

Issues Log

Commissioning Report; G, DO

Post-Construction Trend Log Report; G, DO

Performance Verification Tests; G, DO

Performance Verification Test Report; G, DO

Functional Performance Test Procedures; G, RO

SD-07 Certificates

Certificate of Readiness; G, DO

SD-10 Operation and Maintenance Data

Training Plan; G, RO

Training Attendance Rosters; G, RO

Systems Manual; G, DO

Systems Manual G, DO

Maintenance and Service Life Plans; G, DO

SD-11 Closeout Submittals

Final Commissioning Report; S, DO

Final Construction Phase Commissioning Plan; S

1.7 COMMISSIONING FIRM

Provide a Commissioning Firm that is certified in commissioning by one of the following: the AABC Commissioning Group (ACG); the Building Commissioning Association (BCA); the Association of Energy Engineers (AEE). The Commissioning Firm must be certified in all systems to be commissioned to the extent such certifications are available from the certifying body. Describe any lapses in certification or disciplinary action taken by the certifying body against the proposed Commissioning Firm or Lead Commissioning Specialist in detail. Any firm or commissioning professional that has been the subject of disciplinary action by the certifying body within the five years preceding contract award is not eligible to perform any duties related to commissioning.

a. Submit the Commissioning Firm's certification of qualifications including the name of the firm and certifications no later than 60 calendar days after Notice to Proceed. Submit an electronic copy.

b. The Commissioning Firm's and Commissioning Specialists' certifications must be maintained for the entire duration of the duties specified herein. If, for any reason, the firm or a specialist loses a certification during this period, immediately notify the Contracting Officer's Representative and submit another Commissioning Firm or Commissioning Specialist for approval. All work specified in this specification section performed by the Commissioning Firm or associated Commissioning Specialists is invalid if the Commissioning Firm or Commissioning Specialist loses its certification prior to contract completion and must be performed by an approved successor.

c. The Commissioning Firm must oversee and assist the General or Prime Contractor with the work specified herein. Submit the Commissioning Firm's Contract including the Scope of Work associated with the paragraph POST-CONSTRUCTION SUPPORT no later than 30 calendar days

after approval of the Commissioning Firm. Submit an electronic copy.

1.7.1 Lead Commissioning Specialist

The Commissioning Firm must provide a Lead Commissioning Specialist (CxC) that has a minimum of five years of commissioning experience, including two projects of similar size and complexity, and that is one of the following: ACG Certified Commissioning Authority (CxA); BCA Certified Commissioning Professional (CCP); AEE Certified Building Commissioning Professional (CBCP); University of Wisconsin-Madison Qualified Commissioning Process Provider (QCxP); ASHRAE Commissioning Process Management Professional (CPMP).

a. Submit the Lead Commissioning Specialist's certification of qualifications including the name of the specialist and firm; certifications; years of experience; and a listing of representative projects of similar size and complexity no later than 30 calendar days after Notice to Proceed. Submit an electronic copy.

b. The Lead Commissioning Specialists certifications must be maintained for the entire duration of the duties specified herein. If, for any reason, the specialist loses a certification during this period, immediately notify the Contracting Officer's Representative and submit another Lead Commissioning Specialist for approval. All work specified in this specification section to be performed by the Lead Commissioning Specialist is invalid if the Lead Commissioning Specialist loses its certification prior to contract completion and must be performed by an approved successor.

c. The Lead Commissioning Specialist must lead and oversee the commissioning work specified herein and be the primary point of contact for the Government regarding the commissioning work. One of the Technical Commissioning Specialists may be the Lead Commissioning Specialist provided that all of the qualification requirements are met.

1.7.2 Technical Commissioning Specialists

Technical Commissioning Specialists, employed by the Commissioning Firm and that have the following qualifications, must perform the technical work specified herein associated with each system to be commissioned:

a. Mechanical Technical Commissioning Specialist: The technical work associated with mechanical systems including Heating, Ventilating, Air Conditioning, and Refrigeration Systems; Building Automation System; Utility Monitoring and Control System; Plumbing Systems; Energy and Water Utility Metering Systems must be performed by a Commissioning Specialist certified by ACG or BCA in the commissioning of HVAC systems with five years of experience in the commissioning of HVAC systems.

b. Electrical Technical Commissioning Specialist: The technical work associated with electrical systems including Lighting Systems; Power Distribution Systems; Power Generation Systems; Electrical Utility Metering Systems must be performed by an engineering technician certified by the InterNational Electrical Testing Association (NETA) with five years of experience inspecting, testing, and calibrating electrical distribution and generation equipment, systems, and devices.

c. Building Envelope Technical Commissioning Specialist: The technical

work associated with the Building Envelope system must be performed by a registered architect with five years of building envelope design or construction experience. The Building Envelope Technical Commissioning Specialist must have experience coordinating and instructing personnel involved in installation, joining, and sealing of air barrier materials and components.

d. Submit the Technical Commissioning Specialist's certification of qualifications including the name of the specialist and firm; certifications; years of experience; and a listing of representative projects of similar size and complexity no later than 30 calendar days after Notice to Proceed. Submit an electronic copy.

1.7.3 Commissioning Standard

Comply with the requirements of the commissioning standard under which the Commissioning Firm and Specialists qualifications are approved. When the firm and specialists are certified by BCA, AEE, ASHRAE, or the University of Wisconsin-Madison, comply with the requirements of one of the acceptable standards unless otherwise stated herein. The acceptable standards are ACG Commissioning Guideline, NEBB Commissioning Standard, SMACNA 1429, or ASHRAE 202. Comply with applicable NETA testing standards for electrical systems.

a. Implement all recommendations and suggested practices contained in the Commissioning Standard and electrical test standards.

b. Use the Commissioning Standard for all aspects of Commissioning, including calibration of instruments.

c. Where the instrument manufacturer calibration recommendations are more stringent than those listed in the Commissioning Standard, adhere to the manufacturer calibration recommendations.

d. All quality assurance provisions of the Commissioning Standard such as performance guarantees are part of this contract.

e. The Commissioning Specialists must develop commissioning procedures for any systems or system components not covered in the Commissioning Standard.

f. Use any new requirements, recommendations, and procedures published or adopted prior to contract solicitation by the body responsible for the Commissioning Standard.

1.8 SUSTAINABILITY THIRD PARTY CERTIFICATION (TPC)

The Commissioning Specialists must execute and document the commissioning activities required of the Commissioning Authority for the purposes of complying with the Third Party Certification (TPC) requirements for the project in accordance with Section 01 33 29 SUSTAINABILITY REPORTING. Provide all commissioning documentation required to meet the TPC requirements.

The Commissioning Specialists must provide any additional documentation or perform additional acitivities required by Leadership in Energy and Environmental Design version 4 (LEEDv4) Fundamental Commissioning and Verification including such documents as the Current Facilities Requirements and Operations and Maintenance Plan. In addition, the

Commissioning Specialists must provide any additional documentation and perform additional activities as required by LEEDv4 Enhanced Commissioning Option 1: Path 1 Enhanced Commissioning and Option 2 Envelope Commissioning including such activities as developing and providing an ongoing commissioning plan, and compliance with NIBS Guideline 3 for envelope commissioning.

1.9 ISSUES LOG

The Lead Commissioning Specialist must develop and maintain an Issues Log for tracking and resolution of all deficiencies discovered through submittal reviews, inspection, and testing. Include the date of final resolution of issues as confirmed by the Commissioning Specialist. Submit the Issues Log on a monthly basis at a minimum. At any point during construction, any commissioning team member finding deficiencies may communicate those deficiencies in writing to the Commissioning Specialist for inclusion into the Issues Log.

Track construction deficiencies identified in the Issues Log using QCS as specified in Specification Section 01 45 00.15 10 RESIDENT MANAGEMENT SYSTEM CONTRACTOR MODE(RMS CM).

1.10 CERTIFICATE OF READINESS

Prior to scheduling Functional Performance Tests for each system, issue a Certificate of Readiness for the system certifying that the system is ready for Functional Performance Testing. The Certificate of Readiness must include, for each system to be commissioned, all equipment and system start-up reports; Performance Verification Test Reports; completed Building Envelope Inspection Checklists; completed Pre-Functional Checklists; Testing, Adjusting, and Balancing (TAB) Report; HVAC Controls Start-Up Reports; and the Air Leakage Test Reports and Diagnostic Test Reports to the extent applicable to the system. The Contractor; the Lead Commissioning Specialist; the Contractor's Quality Control Representative; the Mechanical, Electrical, Controls, and TAB subcontractor representatives must sign and date the Certificate of Readiness. Submit the Certificate of Readiness for each system no later than 14 calendar days prior to Functional Performance Tests of that system. Submit an electronic copy. Do not schedule Functional Performance Tests for a system until the Certificate of Readiness for that system receives approval by the Government.

PART 2 PRODUCTS

Not used

PART 3 EXECUTION

3.1 CONSTRUCTION PHASE

3.1.1 Construction Commissioning Coordination Meeting

The Lead Commissioning Specialist must lead a Construction Commissioning Coordination Meeting no later than 14 days after approval of the Commissioning Firm and Commissioning Specialists to discuss the commissioning process including contract requirements, lines of communication, roles and responsibilities, schedules, documentation requirements, inspection and test procedures, and logistics as specified in this specification section. The Contractor's Superintendent or Project

Manager, the Contractor's Quality Control Representative, and the Government must attend this meeting. Invite the User and a Directorate of Public Works Representative to attend this meeting.

3.1.2 Design Phase Commissioning Plan

A commissioning plan developed during design phase is provided as Appendix C for information only. The design phase commissioning plan does not form a part of this contract and is provided for commissioning review purposes only.

3.1.3 Construction Phase Commissioning Plan

3.1.3.1 Interim Construction Phase Commissioning Plan

The Lead Commissioning Specialist (CxC) must prepare the Interim Construction Phase Commissioning Plan. Submit the Interim Construction Phase Commissioning Plan no later than 30 calendar days after the Construction Commissioning Coordination Meeting and no later than 14 days prior to the start of construction of the building envelope. Submit an electronic copy.

Identify the commissioning and testing standards and outline the overall commissioning process, the commissioning schedule, the commissioning team members and responsibilities, lines of communication, documentation requirements for the construction phase of the project, and Template Building Envelope Inspection Checklists in the Interim Construction Phase Commissioning Plan.

3.1.3.1.1 Checklists

Sample Building Envelope Inspection Checklists, Pre-Functional Checklists, Integrated Systems Test Checklists, and Functional Performance Test Checklists for specification section 01 91 00.15 10 TOTAL BUILDING COMMISSIONINGare included in the Design Phase Commissioning Plan in Appendix C. The checklists submitted in the Interim and Final Construction Phase Commissioning Plans must contain the same level of detail shown in the examples. The submitted checklists are not required to match the format of the examples.

3.1.3.1.2 Template Building Envelope Inspection Checklists

The Building Envelope Technical Commissioning Specialist must develop the Template Building Envelope Inspection Checklists. Include all items that verify the building materials and construction maintain the required thermal and moisture integrity and air tightness of the building envelope system in the Building Envelope Inspection Checklists.

3.1.3.2 Final Construction Phase Commissioning Plan

The Lead Commissioning Specialist (CxC) must prepare the Final Construction Phase Commissioning Plan. Submit the Final Construction Phase Commissioning Plan no later than 30 calendar days prior to the start of Pre-Functional Checks. Submit an electronic copy. Once approved, file the approved plan in the Sustainability eNotebook.

Include the information provided in the Interim Construction Phase Commissioning Plan. In addition, the Technical Commissioning Specialist

must develop the Pre-Functional Checklists, Integrated Systems Test Checklists, and Functional Performance Test Checklists for each building, for each system required to be commissioned, and for each component for inclusion in the Final Construction Phase Commissioning Plan.

3.1.3.2.1 Pre-Functional Checklists

The Pre-Functional Checklists must include items for physical inspection or testing that demonstrate that installation and start-up of equipment and systems is complete. Refer to paragraph Pre-Functional Checks for more information.

3.1.3.2.2 Functional Performance Test Checklists

Functional Performance Test Checklists must include procedures that explain, step-by-step, the actions and expected results that will demonstrate that the system performs in accordance with the contract. Refer to paragraph Functional Performance and Integrated Systems Tests for more information. Include the following sections and details appropriate to the systems being tested in the Functional Performance Test Checklists:

a. Notable system features including information about controls to facilitate understanding of system operation

b. Conclusions and recommendations. Conclusions must clearly indicate if system does or does not perform in accordance with contract requirements. Recommendation must clearly indicate that the system should or should not be accepted by the Government.

c. Test conditions including date, beginning and ending time, and beginning and ending outdoor air conditions

d. Attendees

e. Identification of the equipment involved in the test

f. Control system feature identification

g. Point-to-point observations including demonstrating system flow meters and sensors have been calibrated and are correctly displayed on the Operator work station

h. Actuator operation observations demonstrating actuator responses to commands from the control system

i. As-found condition of the system operation

j. List of test items with step numbers along with the corresponding feature or control operation, intended test procedure, expected system response, and pass/fail indication.

k. Space for comments for each test item.

3.1.3.2.3 Integrated Systems Test Checklists

Integrated Systems Test Checklists must include test procedures that explain, step-by-step, the actions and expected results that will demonstrate that the interactive operations between systems performs in accordance with the contract. Refer to paragraph Functional Performance

and Integrated Systems Tests for more information. Include the following sections in the Integrated Systems Test Checklists:

a. Notable features of the interconnected systems organized by discipline including information to facilitate understanding of system operation

b. Conclusions and recommendations. Conclusions must clearly indicate if the systems do or do not perform in accordance with contract requirements. Recommendation must clearly indicate that the systems should or should not be accepted by the Government

c. Test conditions including date and beginning and ending time

d. Attendees

e. Identification of the equipment and systems involved in the test

f. List of test items with step numbers along with the corresponding feature or control operation, intended test procedure, expected system response, and pass/fail indication.

g. Space for comments for each test item.

3.1.4 Construction Submittals

Provide all submittals associated with the systems to be commissioned, including shop drawings; equipment submittals; test plans, procedures, and reports; and resubmittal's to the Commissioning Specialists. The Technical Commissioning Specialist must review the submittals to the extent necessary verify that the equipment and system installation will comply with the contract requirements and the requirements of the Basis of Design and the Government's Project Requirements Document.

3.1.5 Inspection and Testing

Demonstrate that all system components have been installed, that each control device and item of equipment operates, and that the systems operate and perform, including interactive operation between systems, in accordance with contract documents and the Government's Project Requirements. Requirements in related specification sections are independent from the requirements of this section and do not satisfy any of the requirements specified in this specification section. Provide all materials, services, and labor required to perform the Pre-Functional Checks, Building Envelope Inspection, Integrated Systems Tests, and Functional Performance Tests.

3.1.5.1 Commissioning Team

Provide a commissioning representative for each sub-contractor associated with the systems to be commissioned. Each commissioning representative is responsible for coordination of their respective sub-contractor's execution of the commissioning activities and participation in the inspection and testing required by this specification section. The designers listed below are the designers of record for their respective systems. Substitutes must be approved by the Contracting Officer's Representative.

3.1.5.1.1 Building Envelope Inspections Team

The following team members must participate in building envelope inspections:

Designation	Function
CxB	Building Envelope Technical Commissioning Specialist
QAR	Contracting Officer's Quality Assurance Representative
CQC	Contractor's Quality Control Personnel
BEC	Contractor's Building Envelope Commissioning Representative
AD	Architectural Designer

3.1.5.1.2 Mechanical System Pre-Functional Checks Team

The following team members must participate in Pre-Functional checks of mechanical systems:

Designation	Function
CxM	Mechanical System Technical Commissioning Specialist
QAR	Contracting Officer's Quality Assurance Representative
CQC	Contractor's Quality Control Personnel
MC	Contractor's Mechanical Commissioning Representative
EC	Contractor's Electrical Commissioning Representative
CC	Contractor's Controls Commissioning Representative
TABC	Contractor's TAB Commissioning Representative

3.1.5.1.3 Electrical System Pre-Functional Checks Team

The following team members must participate in Pre-Functional checks of electrical systems:

Designation	Function
CxE	Electrical System Technical Commissioning Specialist
QAR	Contracting Officer's Quality Assurance Representative
CQC	Contractor's Quality Control Personnel

Designation	Function
EC	Contractor's Electrical Commissioning Representative

3.1.5.1.4 Plumbing System Pre-Functional Checks Team

The following team members must participate in Pre-Functional checks of plumbing systems:

Designation	Function
CxE	Plumbing System Technical Commissioning Specialist
QAR	Contracting Officer's Quality Assurance Representative
CQC	Contractor's Quality Control Personnel
PC	Contractor's Plumbing Commissioning Representative

3.1.5.1.5 Sprinkler System Pre-Functional Checks Team

The following team members must participate in Pre-Functional checks of sprinkler systems:

Designation	Function
CxE	Sprinkler System Technical Commissioning Specialist
QAR	Contracting Officer's Quality Assurance Representative
CQC	Contractor's Quality Control Personnel
FPC	Contractor's Sprinkler Commissioning Representative

3.1.5.1.6 Fire Alarm System Pre-Functional Checks Team

The following team members must participate in Pre-Functional checks of fire alarm systems:

Designation	Function
CxE	Fire Alarm System Technical Commissioning Specialist
QAR	Contracting Officer's Quality Assurance Representative
CQC	Contractor's Quality Control Personnel

Designation	Function
FAC	Contractor's Fire Alarm Commissioning Representative

3.1.5.1.7 Mechanical Systems Test Team

The following team members must participate in Functional Performance, Seasonal, and Integrated Systems Testing of mechanical systems:

Designation	Function
CxM	Mechanical System Technical Commissioning Specialist
QAR	Contracting Officer's Quality Assurance Representative
CQC	Contractor's Quality Control Personnel
MC	Contractor's Mechanical Commissioning Representative
EC	Contractor's Electrical Commissioning Representative
CC	Contractor's Controls Commissioning Representative
TABC	Contractor's TAB Commissioning Representative

3.1.5.1.8 Electrical Systems Test Team

The following team members must participate in Functional Performance and Integrated Systems Testing of electrical systems:

Designation	Function
CxE	Electrical System Technical Commissioning Specialist
QAR	Contracting Officer's Quality Assurance Representative
CQC	Contractor's Quality Control Personnel
EC	Contractor's Electrical Commissioning Representative

3.1.5.1.9 Plumbing Systems Test Team

The following team members must participate in Functional Performance of plumbing systems:

Designation	Function
CxE	Plumbing System Technical Commissioning Specialist

Designation	Function
QAR	Contracting Officer's Quality Assurance Representative
CQC	Contractor's Quality Control Personnel
PC	Contractor's Plumbing Commissioning Representative

3.1.5.1.10 Sprinkler Systems Test Team

The following team members must participate in Functional Performance of fire protection systems:

Designation	Function
CxE	Fire Protection System Technical Commissioning Specialist
QAR	Contracting Officer's Quality Assurance Representative
CQC	Contractor's Quality Control Personnel
FPC	Contractor's Fire Protection Commissioning Representative

3.1.5.1.11 Fire Alarm Systems Test Team

The following team members must participate in Functional Performance of fire alarm systems:

Designation	Function
CxE	Fire Alarm System Technical Commissioning Specialist
QAR	Contracting Officer's Quality Assurance Representative
CQC	Contractor's Quality Control Personnel
FAC	Contractor's Fire Alarm Commissioning Representative

3.1.5.1.12 Other Pre-Functional and Functional Performance Participants

The following may participate as team members during Pre-Functional Checks and Functional Performance Testing:

Designation	Function
DPW	Directorate of Public Works Representative
BCE	Base Civil Engineer Office Representative

Designation	Function
User	Using Agent's Representative

3.1.5.2 Building Envelope Inspection

Document building envelope inspection by the commissioning team using the approved Template Building Envelope Inspection Checklists. Indicate commissioning team member inspection and acceptance of each Building Envelope Inspection Checklist item by initials at the time they are inspected and found to be in conformance with contract requirements. Inspect checklist items before they become hidden as construction progresses.

a. Submit the completed and initialed Building Envelope Inspection Checklists no later than 7 calendar days after completion of inspection of all checklists items. Submit an electronic copy.

b. The Building Envelope Technical Commissioning Specialist must make at least two site visits to the site to observe construction of the building envelope in-progress. On each visit, the Building Envelope Commissioning Specialist must review the Contractor's in-progress checklists to ensure that the commissioning team is inspecting the building envelope as required.

c. The Building Envelope Technical Commissioning Specialist must witness the building envelope air leakage tests and diagnostic tests specified in Specification Sections 08 39 54 EXTERIOR DOORS and 08 51 13 ALUMINUM WINDOWS. The Building Envelope Technical Commissioning Specialist must review the resulting reports and provide recommendations for correction of any deficiencies or further testing.

3.1.5.3 Pre-Functional Checks

Pre-Functional Checklists from the approved Final Construction Phase Commissioning Plan must be completed by the commissioning team. Complete one Pre-Functional Checklist for each individual item of equipment or system for each system required to be commissioned including, but not limited to, ductwork, piping, equipment, fixtures (lighting and plumbing), and controls. Indicate commissioning team member inspection and acceptance of each Pre-Functional Checklist item by initials. Acceptance of each Pre-Functional Checklist item by each team member indicates that item conforms to the construction contract requirements in their area of responsibility. Technical Commissioning Specialist acceptance of each Pre-Functional Checklist item indicates that each item has been installed correctly and in accordance with contract documents and the Government's Project Requirements. Submit the completed and initialed Pre-Functional Checklists no later than 7 calendar days after completion of inspection of all checklists items for each system. Submit one hard copy and an electronic copy. Include manufacturer start-up checklists associated with equipment with the submission of the Pre-Functional Checklists.

3.1.5.4 Testing, Adjusting, and Balancing (TAB) Report and Field Acceptance Testing

The Mechanical System Technical Commissioning Specialist must review the pre-final TAB Report required by Specification Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC. Identify any deficiencies to the

Contracting Officer's Representative and the Contractor's Quality Control Personnel. Resolve all deficiencies prior to TAB Field Acceptance Testing.

The Mechanical System Technical Commissioning Specialist must witness the TAB Field Acceptance Testing specified by Specification Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC. Include a certification by the Mechanical Technical Specialist that no outstanding deficiencies exist in the systems relative to Testing, Adjusting, and Balancing with the final TAB Report submittal.

3.1.5.5 Controls Test Reports

The Mechanical System Technical Commissioning Specialist must review the Start-Up Testing Report and the PVT Procedures and Reports required by Specification Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC and Specification Section 25 10 10 UTILITY MONITORING AND CONTROL SYSTEM (UMCS) Front End and Integration. Include a certification by the Mechanical System Technical Commissioning Specialist that the submittals contain no deficiencies or that the submittals do not indicate any deficiencies in the HVAC systems or HVAC control systems with each of these submittals.

The Electrical System Technical Commissioning Specialist must review the Start-Up Testing Reports and acceptance testing reports specified in Specification Section 26 08 00 APPARATUS INSPECTION AND TESTING and System Operation Tests specified in Specification Section 26 09 43 LIGHTING CONTROLS. Include a certification by the Electrical System Technical Commissioning Specialist that the submittals contain no deficiencies or that the submittals do not indicate any deficiencies in the power systems or lighting control systems with each of these submittals.

3.1.5.6 Tests

3.1.5.6.1 Functional Performance and Integrated Systems Tests

Schedule Functional Performance Tests for each system only after the Certificate of Readiness has been approved by the Government for the system. Correct all deficiencies identified through any prior review, inspection, or test activity before the start of Functional Performance Tests. Perform Integrated Systems Tests only after the Functional Performance Tests for each associated system are completed with all deficiencies resolved and after the related Functional Performance Test Checklists have been signed by each commissioning team member.

a. Functional Performance Tests and Integrated Systems Tests must be performed with the Contracting Officer's Quality Assurance Representative present.

b. Abort Functional Performance Tests or Integrated Systems Tests when any system deficiency prevents the successful completion of the test.

c. Technical Commissioning Specialists must lead and document all Functional Performance Tests and Integrated Systems Tests for the systems to be commissioned with the Contractor and appropriate sub-contractors performing the Functional Performance Tests and Integrated Systems Tests. The representatives listed in the paragraph Commissioning Team must attend the tests. Abort Functional Performance Tests or Integrated Systems Tests when any required

commissioning team member is not present for the test.

3.1.5.6.1.1 Checklist

Use the Functional Performance Test and Integrated Systems Test Checklists from the approved Final Construction Phase Commissioning Plan to guide the Functional Performance Tests and Integrated Systems Tests. Functional Performance Tests must be performed for each item of equipment and each system required to be commissioned and verify all sensor calibrations, control responses, safeties, interlocks, operating modes, sequences of operation, capacities, lighting levels, and all other performance requirements comply with construction contract regardless of the specific items listed within the Functional Performance Test and Integrated Systems Test Checklists provided. Testing must progress from equipment or components to subsystems to systems to interlocks and connections between systems. Integrated Systems Tests must be performed for the interactive operation between systems such as HVAC systems, fire protection systems, back-up electrical supply, energy generation systems, and other systems, and verify correct interactive operation, acceptable speed of response, and other contract requirements for both normal and failure modes. Examples of Integrated Systems Tests include the correct operation of HVAC systems during emergency system activation, correct operation of uninterruptible power supplies or energy generators and connected systems, or lighting system operation during power outage or emergency system activation. The order of components and systems to be tested must be determined by the Technical Commissioning Specialists.

3.1.5.6.1.2 Acceptance

Indicate acceptance of each item of equipment and systems tested by signature of each commissioning team member for each Functional Performance Test or Integrated Systems Test Checklist. The Contractor's Quality Control Representative and the Technical Commissioning Specialists must indicate acceptance after the equipment and systems are free of deficiencies.

3.1.5.6.2 HVAC Test Methods

Perform Functional Performance Tests in accordance with the following:

3.1.5.6.2.1 Prior to Testing

Prior to testing operating modes, sequences of operation, interlocks, and safeties, complete control point-to-point observations, test sensor calibrations, and test actuator commands.

3.1.5.6.2.2 Simulating Conditions

Over-writing control input values through the controls system is not acceptable, unless approved by the Contracting Officer's Representative. Identify proposed exceptions in a protocol submitted to the Contracting Officer's Representative for approval. Before simulating conditions, overwriting values (if approved), or changing set-points, calibrate all sensors, transducers and devices. Below are several examples of exceptions that would be considered acceptable:

a. When varying static pressures inside ductwork can not be simulated within the duct, and where a sensor signals the controls system to initiate sequences at various duct static pressures, it is acceptable

to simulate the various pressures with a Pneumatic Squeeze-Bulb Type Signaling Device with gauge temporarily attached to the sensing tube leading to the transmitter. It is not acceptable to reset the various set-points, nor to simulate an electric analog signal (unless approved as noted above).

b. Dirty filter pressure drops can be simulated using sheets of cardboard at filter face.

c. Freeze-stat safeties can be simulated by packing portion of sensor with ice.

d. High outside air temperatures can be simulated with a hair blower.

e. High entering cooling coil temperatures can be used to simulate entering cooling coil conditions.

f. Do not use signal generators to simulate sensor signals unless approved by the Contracting Officer's Representative, as noted above, for special cases.

g. Control set points can be altered. For example, to see the air conditioning compressor lockout work at an outside air temperature below 55 degrees F, when the outside air temperature is above 55 degrees F, temporarily change the lockout set point to be 0 degrees F above the current outside air temperature. Caution: Set points are not to be raised or lowered to a point such that damage to the components, systems, or the building structure and/or contents will occur.

h. Test duct mounted smoke detectors in accordance with the manufacturer's recommendations. Perform the tests with air system at minimum airflow condition in ductwork.

i. Test current sensing relays used for fan and pump status signals to control system to indicate unit failure and run status by resetting the set point on the relay to simulate a lost belt or unit failure while the unit is running. Confirm that the failure alarm was generated and received at the control system. After the test is conducted, return the set point to its original set-point or a set-point as indicated by the Contracting Officer's Representative.

3.1.5.6.2.3 Setup

Perform each test under conditions that simulate actual conditions as close as is practically possible. Provide all necessary materials and system modifications to produce the necessary flows, pressures, temperatures, and other conditions necessary to execute the test according to the specified conditions. At completion of the test, return the affected building equipment and systems to their pre-test condition.

3.1.5.6.3 Sample Strategy

Perform Functional Performance Tests using the following sample strategy. Prepare and complete a Functional Performance Test Checklist for each item of equipment or system to be tested. For sample sizes less than 100 percent for all similar equipment, the Government will select the specific equipment or system to be tested during testing. Equipment Identifiers are as indicated on the design drawings:

Equipment Identifier	Sample Size (Percent)
AHU	100
Terminal Units (VAV, FCU, Radiant Panels)	20
Exhaust/Ventilation Fans	100
Humidifier/ Dehumidifier	100
Chilled Water Chiller, HX, Pumps, Deny Valve)	100
Lighting Controls	25
Heating Hot Water (Boiler, HX, Pumps,Steam Condensate Return)	100
Domestic Hot Water Heaters	35 of each type
Generator	100
Sprinkler Systems	100
Fire Alarm / Mass Notification Control Panels	100
Utility Metering	100

Perform Integrated Systems Tests for all systems and equipment having interactive operation.

3.1.5.6.4 Seasonal Tests

3.1.5.6.4.1 Initial Functional Performance Tests

Perform Initial Functional Performance Tests as soon as all contract work is completed, regardless of the season. Develop and implement means of artificial loading to demonstrate, to a reasonable level of confidence, the ability of the HVAC systems to handle peak seasonal loads.

3.1.5.6.4.2 Full-Load Conditions

In addition to the Initial Functional Performance Tests, perform Functional Performance Tests of HVAC systems under full-load conditions during peak heating and cooling seasons during outdoor air condition design extremes.

Schedule Seasonal Functional Performance Tests in coordination with the Government.

3.1.5.6.4.3 System Acceptance

Systems may be partially accepted by the Government prior to seasonal testing if they comply with all construction contract that can be tested during initial Functional Performance Tests. All Functional Performance

Test procedures must be completed prior to full systems acceptance.

3.1.5.6.5 Aborted Tests and Re-Testing

Abort Functional Performance Tests, Integrated Systems Tests, or Seasonal Tests if any deficiency prevents successful completion of the test or if any required commissioning team member is not present for the test. Reimburse the Government for all costs associated with effort lost due to re-testing due to test failures and aborted tests. These costs must include salary, travel costs, and per diem for Government commissioning team members. Re-test only after all deficiencies identified during the original tests have been corrected.

3.1.5.6.5.1 100 Percent Sample

Systems or equipment for which 100 percent sample size are tested fail if one or more of the test procedures results in discovery of a deficiency and the deficiency cannot be resolved within 5 minutes during the test.

Re-test to the extent necessary to confirm that the deficiencies have been corrected without negatively impacting the performance of the rest of the system.

3.1.5.6.5.2 Less than 100 Percent Sample

For systems tests with a sample size less than 100 percent, if one or more of the test procedures for an item of equipment or a system results in discovery of a deficiency, regardless of whether the deficiency is corrected during the sample tests, the item of equipment or system fails the test.

a. If the system failure rate is 5 percent or less, meaning that 5 percent or less of the equipment or systems tested had at least one deficiency, re-test only on the items which experienced the initial failures.

b. If the system failure rate is higher than 5 percent, meaning that more than 5 percent of equipment or systems tested had at least one deficiency, re-test the items which experienced the initial failures to the extent necessary to confirm that the deficiencies have been corrected . In addition, test another random sample of the same size as the initial sample for the first time. If the second random sample set has any failures, re-test those failed items and all remaining equipment and systems to complete 100 percent testing of that system type.

3.1.6 Training Plan

Develop a training plan which identifies all training required by specification sections associated with commissioned systems. Include a matrix listing each training requirement, content of the training, the trainer name, trainer contact information, and schedule and location of training. Submit an electronic copy of the Training Plan to the Commissioning Specialists and the Government no later than 30 calendar days prior to the associated training.

Document training attendance using training attendance rosters and provide completed attendance rosters to the Commissioning Specialists and the Government no later than 7 calendar days following the completion of

training for each system to be commissioned. Submit an electronic copy.

3.1.7 Systems Manual

Prepare and submit a Systems Manual including a signed certification or letter from the Technical Commissioning Specalists and the Lead Commissioning Specialist stating that the Systems Manual is complete, clear, and accurate. The Systems Manual, for all commissioned systems, must conform to Appendix A SYSTEMS MANUAL ORGANIZATION AND CONTENT to ER 25-345-1, available at the USACE Publications website at the following location: https://www.publications.usace.army.mil/USACE-Publications/Engineer-Regulations/. Update and resubmit the Systems Manual based on any corrective action taken during the warranty period.

Submit Systems Manual no later than 30 calendar days following completion of Functional Performance Tests and Integrated Systems Tests. Submit an electronic copy.

3.1.8 Maintenance and Service Life Plans

3.1.8.1 Maintenance Plan

Prepare and submit a Maintenance Plan for the project mechanical, electrical, plumbing, and fire protection systems. Prepare the HVAC and refrigeration sections of the Maintenance Plan in accordance with ASHRAE 180. Develop required inspection and maintenance tasks similar to Section 5 of ASHRAE 180 for the other commissioned systems and fire protection systems.

Submit the Maintenance Plan no later than 30 calendar days following the completion of Functional Performance Tests and Integrated Systems Tests. Submit three hard copies and an electronic copy.

3.1.8.2 Service Life Plan

Prepare and submit a Service Life Plan for the building envelope, structural systems, and site hardscape that includes the following for each assembly or component:

a. A description of each including the materials or products.

b. The estimated service life, in years.

c. The estimated maintenance frequency and description of maintenance tasks.

d. The point of maintenance access for the components with estimated service life less than service life of the building.

Submit the Service Life Plan no later than 30 calendar days following the completion of Functional Performance Tests and Integrated Systems Tests. Submit an electronic copy.

3.1.8.3 Design Life

Building Design Life (years)	Building Element Design Life (years)					
	Structural elements and/or inaccessible elements	Expensive and/or difficult replacement	Major replaceable	Mechanical, electrical, plumbing,and energy generation	Roofing	Site hardscape
60	60	60	40	20	20	30

3.2 COMMISSIONING REPORT

Following the completion of Functional Performance Tests and Integrated Systems Tests, with the exception of Seasonal Tests, the Lead Commissioning Specialist must prepare a Commissioning Report.

a. Include an executive summary describing the overall commissioning process, the results of the commissioning process, any outstanding deficiencies and recommended resolutions, and any seasonal testing that must be scheduled for a later date. Indicate, in the executive summary, whether the systems meet the requirements of the construction contract and the Government's Project Requirements.

b. Detail any deficiencies discovered during the commissioning process and the corrective actions taken in the report. Include the completed Building Envelope Inspection Checklists, Pre-Functional Checklists, Functional Performance Test Checklists, Integrated Systems Test Checklists,the Commissioning Plans, the Issues Log, Performance Verification Test Reports, Training Attendance Rosters, the Design Review Report, the final TAB Report.

c. Submit the Commissioning Report no later than 14 calendar days following commissioning team acceptance of all Functional Performance Tests and Integrated Systems Tests with the exception of Seasonal Tests. Submit an electronic copy.

d. Following any Seasonal Tests or Post-Construction Activities, update the Final Commissioning Report to reflect any changes and resubmit. File the approved, updated, Final Commissioning Report in the Sustainability eNotebook.

3.3 POST-CONSTRUCTION SUPPORT

3.3.1 Post-Construction Endurance Test

Perform an Endurance Test in accordance with the paragraph Endurance Test in Specification Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC once during the peak heating season and once during the peak cooling season during outdoor air condition extremes with the exception that network bandwidth usage measurement and recording is not required.

The Mechanical System Commissioning Specialists must review the trend logs from the Endurance Tests to ensure that the systems have stable operation and operate as required by the construction contract, and the Government's Project Requirements Document. The Commissioning Specialists must provide a Post-Construction Trend Log Report that identifies any deficiencies noted in operation, recommendations for correction, and includes a graphical representation of the trends. Provide one Trend Log Report for the peak cooling season and one Trend Log Report for the peak heating season. Submit an electronic copy of the Post-Construction Trend Log Reports no later than 14 calendar days following receipt of the trend log data by the Commissioning Specialist.

3.3.2 Post-Construction Site Visit

The Commissioning Specialists must visit the building site concurrent with the 9 month warranty inspection to inspect building system equipment and review building operation with the building operating/maintenance staff. The Commissioning Specialists must identify any deficiency of the building systems to operate in accordance with the contract requirements and the Government's Project Requirements. The Commissioning Specialists must advise the Contracting Officer's Representative of any identified deficiencies and the proposed corrective action. Submit an updated commissioning report and systems manual documenting the results of the post-construction inspection.

SECTION 02 85 00

MOLD REMEDIATION
11/18

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN INDUSTRIAL HYGIENE ASSOCIATION (AIHA)

AIHA IMOM08-679	(2008) Recognition, Evaluation, and Control of Indoor Mold

AMERICAN SOCIETY OF SAFETY PROFESSIONALS (ASSP)

ASSP Z9.2	(2018) Fundamentals Governing the Design and Operation of Local Exhaust Ventilation Systems

INSTITUTE OF INSPECTION, CLEANING, AND RESTORATION CERTIFICATION (IICRC)

ANSI/IICRC S520	(2015) Standard and Reference Guide for Professional Mold Remediation
IICRC S500	(2015) Standard and Reference Guide for Professional Water Damage Restoration

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.134	Respiratory Protection
29 CFR 1926.59	Hazard Communication
29 CFR 1926.62	Lead
29 CFR 1926.1101	Asbestos
29 CFR 1926.1126	Chromium
29 CFR 1926.1127	Cadmium

NAVY AND MARINE CORPS PUBLIC HEALTH CENTER (NMCPHC)

IHFOM, CH 13, Sec. 3	(2015) Mold Cleanup, Remediation, and Clearance Sampling

NEW YORK STATE DEPARTMENT OF LABOR (NYS)

NYS 32 § 930-940	Licensing of Mold Inspection, Assessment and Remediation Specialists and Minimum Work Standards

UNDERWRITERS LABORATORIES (UL)

UL 586	(2009; Reprint Dec 2017) UL Standard for Safety High-Efficiency Particulate, Air Filter Units

1.2 DEFINITIONS

The below definitions must not supercede NYS 32 § 930 definitions.

1.2.1 AIHA

American Industrial Hygiene Association.

1.2.2 AIHA EMLAP

American Industrial Hygiene Association's Environmental Microbiology Laboratory Accreditation Program

1.2.3 AFU

Air filtration unit with High Efficiency particulate air (HEPA) filtered vacuum and exhaust ventilation equipment with a filter system capable of collecting and retaining microbial contamination ASSP Z9.2. Filters must retain 99.97 percent of particles 0.000012 inches or larger as indicated in UL 586.

1.2.4 Categories of Water

Category 1 Water: Water that originates from a sanitary water source and does not pose a substantial risk from dermal, ingestion, or inhalation exposure. IICRC S500

Category 2 Water: Water that contains significant contamination and has the potential to cause discomfort or sickness if contacted or consumed by humans. Can contain potentially unsafe levels of microorganisms or nutrients for microorganisms as well as other organic or inorganic matter. IICRC S500

Category 3 Water: Water that is grossly contaminated and can cause significant adverse reactions to humans if contacted or consumed. IICRC S500

1.2.5 Certified Industrial Hygienist (CIH)

An individual that has been certified by the American Board of Industrial Hygiene (ABIH), with professional qualifications and experience as required for an industrial hygienist, as presented in the definition of "Industrial Hygienist."

1.2.6 Complete Interior Building Demolition (Complete Gut)

Interior finishes of the building have been removed to expose basic structural elements.

1.2.7 Containment

Physical separation and engineering controls required to prevent contamination of undamaged materials and occupied areas. The level of

containment varies depending on the extent of the contamination.

1.2.7.1 Source Containment

Use when the contaminated surface area is less than 10 square feet, in both residential and non-residential buildings. At a minimum, source containment will include the following (ANSI/IICRC S520 and NYS 32 § 930-940):

a. Isolation of Work Areas. Install polyethylene barriers to isolate the areas or material to be demolished / remediated from non-remediation areas.

b. Floor protection. Maintain protection for finished floors through all construction activities.

c. HEPA vacuum to control dust created during the demolition. Hold HEPA vac intake at source of dust.

1.2.7.2 Limited Containment

Use when contaminated surface area is between 10 square feet and 100 square feet per room in both residential and non-residential buildings. At a minimum, limited containment includes the following (ANSI/IICRC S520 and NYS 32 § 930-940):

a. Containment. For residential buildings, a containment includes the entire room where work is being performed. The containment does not extend past the extents of the room unless there are instances of contamination extending from one room to the next. For non-residential buildings, the containment includes the area to be remediated, plus enough additional area to allow for all equipment and work activities.

b. Isolation of Work Areas. Install polyethylene barriers to isolate the areas to be demolished / remediated.

c. Floor protection. Maintain protection for finished floors through all construction activities.

d. Air Filtration / Pressurization Control. Install AFUs with HEPA filters in the containment. Configure the AFUs with splitters / diverters to allow some of the air to recirculate within the containment. Discharge the remainder of the air directly to the outside to maintain an overall negative pressure in the containment of 0.02 inch water column minimum to 0.04 inch water column maximum relative to the outside and other adjacent spaces not undergoing remediation(AIHA IMOM08-679). AFUs must filter a minimum of four air changes per hour and a maximum of six air changes per hour (ANSI/IICRC S520).

e. Protection for all items remaining in the containment. Protective devices must prevent physical damage (e.g., scratches and dents) and must provide a positive seal to prevent dust from settling in or on the items.

f. Decontamination. Construct a decontamination airlock for entry into and exit from the work area. HEPA vacuum the sealed bags of contaminated debris within the airlock. When possible, locate the

decontamination airlock so that the sealed bags can be passed directly from the airlock to the outside, through a door or window.

g. Containment Entrance. Install a triple-flap poly "door" to be used during demolition to provide a good separation between containment and occupied areas of the house / building.

h. HVAC System. Seal off all supply and return vents. HVAC may need to be shut down to ensure proper seal of the vents.

1.2.7.3 Full Containment

Use when contaminated surface area is greater than 100 square feet in both residential and nonresidential buildings. At a minimum, full containment includes the following(ANSI/IICRC S520 and NYS 32 § 930-940):

a. Containment. For residential buildings, a containment includes the entire room where work is being performed. The containment does not extend past the extents of the room unless there are instances of contamination extending from one room to the next. For non-residential buildings, the containment includes the area to be remediated, plus enough additional area to allow for all equipment and work activities.

b. Isolation of Work Areas. Construct polyethylene barriers to isolate the areas to be demolished / remediated.

c. Floor protection. Maintain protection for finished floors through all construction activities.

d. Air Filtration / Pressurization Control. Install AFUs with HEPA filters in the containment. Configure the AFUs with splitters / diverters to allow some of the air to recirculate within the containment. Discharge the remainder of the air directly to the outside to maintain an overall negative pressure in the containment of 0.02 inch water column minimum to 0.04 inch water column maximum relative to the outside and other adjacent spaces not undergoing remediation (AIHA IMOM08-679). AFUs must filter a minimum of four air changes per hour and a maximum of six air changes per hour (ANSI/IICRC S520 and NYS 32 § 930-940).

e. Protection for all items remaining in the containment. Protective devices must prevent physical damage (e.g., scratches and dents) and must provide a positive seal to prevent dust from settling in or on the items.

f. Decontamination. Construct a decontamination airlock for entry into and exit from the work area. HEPA vacuum the sealed bags of contaminated debris within the airlock. When possible, locate the decontamination airlock so that the sealed bags can be passed directly from the airlock to the outside, through a door or window.

g. Containment Entrance. Install a triple-flap poly "door" at the entrance to the airlock, and between the airlock and the work area during demolition to provide a good separation between containment and occupied areas of the house / building.

h. HVAC System. Seal off all supply and return vents. HVAC may need to be shut down to ensure proper seal of the vents.

1.2.7.4 Unoccupied Building Containment

Use when a building is unoccupied and large amounts of mold growth are present throughout the building:

a. Containment. The containment consists of the entire building. Install AFUs with HEPA filters in the building. Configure the AFUs to recirculate within the active remediation area. AFUs must filter a minimum of four air changes per hour and a maximum of six air changes per hour based on the size of the area undergoing active remediation (ANSI/IICRC S520 and NYS 32 § 930-940).

b. Isolation of Work Areas. Install polyethylene barriers to isolate remediation areas from non-remediation areas. AFU discharge may be used to positively pressurize non-remediation areas from areas undergoing remediation to prevent the movement of spores into "clean" areas.

c. Floor Protection. Maintain protection for finished floors through all construction activities.

d. Protection for all items remaining in the containment. Protective devices must prevent physical damage (e.g., scratches and dents) and must provide a positive seal to prevent dust from settling in or on the items.

e. Decontamination. Construct a decontamination airlock for entry into and exit from the building.

f. Containment Entrance. Install a triple-flap poly "door" to be used during demolition to provide a good separation between containment and non-remediation areas of the house / building.

g. HVAC System. Seal off all supply and return vents. HVAC may need to be shut down to ensure proper seal of the vents.

1.2.7.5 Cleaning Containment

For items being salvaged, set up a temporary containment structure to clean items removed from the containment. At a minimum, the cleaning area must contain:

a. Two chambers. Construct walls with polyethylene. Clean the items in the first chamber. Store the clean items in the second chamber.

b. Air Filtration / Pressurization Control Cleaning Chamber. Install AFUs with HEPA filters in the cleaning chamber. Configure the AFUs with splitters / diverters to allow some of the air to recirculate within the containment. Discharge the remainder of the air directly to the outside to maintain an overall negative pressure in the containment of 0.02 inch water column minimum to 0.04 inch water column (maximum) relative to the storage chamber (AIHA IMOM08-679).

c. Air Filtration, Storage Chamber. Install AFUs with HEPA filters in the storage chamber. Configure the AFUs to allow air to recirculate within the chamber. AFUs must provide air filtration at a rate of between four and six air changes per hour (ANSI/IICRC S520 and NYS 32 § 930-940).

d. Containment Entrance. Install a triple-flap poly "door" at the entrance to the cleaning chamber, between the cleaning and storage chambers, and at the exit of the storage chamber to provide a good separation between the chambers.

1.2.8 Decontamination Unit (Airlock)

An enclosed area adjacent to, and connected to, a regulated work area. It consists of various rooms that are used for the decontamination of workers, equipment, and materials.

1.2.9 Dehumidifier

Mechanism or machine to remove moisture from the air.

1.2.10 Detergent

A cleaning agent. The term refers to a prepared compound that may include surfactants, builders, dry solvents, softeners, etc, but does not include true soap.

1.2.11 Disinfectants or Biocide Sanitizing Solutions

One of three groups of antimicrobials registered by the EPA for public health uses. The EPA considers an antimicrobial to be a disinfectant when it destroys or irreversibly inactivates infectious or other undesirable organisms, but not necessarily their spores.

1.2.12 EPA

U.S. Environmental Protection Agency.

1.2.13 Fungal Growth Structures

Portions of fungi indicating active fungal growth is present on a surface. These include spores, conidiophores, hyphae, hyphal fragments, and mycelium.

1.2.14 Fungicidal Agents, (EPA)

An EPA registered fungicide that inhibits the spread and growth of mold with the ability to withstand moist and humid conditions.

1.2.15 HEPA Filter

A High Efficiency Particulate Air (HEPA) filter capable of trapping and retaining 99.97 percent of all particulate larger than 0.000012 inches.

1.2.16 HVAC

Heating, Ventilating, and Air Conditioning (System).

1.2.17 Industrial Hygienist (IH)

An individual designated and provided by the Contractor that is a professional qualified by education, training, and experience to anticipate, recognize, evaluate, and develop controls for occupational and indoor air quality hazards. Education must include a minimum 12 semester

hours or quarter hour equivalent of chemistry and 18 additional semester hours or quarter hour equivalent of courses in any combination of chemistry, physics, engineering, health physics, environmental health, biostatistics, biology, physiology, toxicology, epidemiology, or industrial hygiene. The Industrial Hygienist must be a CIH or under the supervision of a Certified Industrial Hygienist.

1.2.18 Microbial Remediation Supervisor

Individual responsible for the execution of the microbial remediation work as defined by the scope of work. This individual must have documented training in microbial remediation and have at least three years experience in microbial remediation work. The individual must meet the requirements of NYS 32 § 930-940.

1.2.19 Non-Porous Material

A material that does not absorb nor is easily penetrated by liquids, especially water. Generally, non-porous materials have a permeable factor of less than one. Some examples are metal, glass, plastic, ceramic tile.

1.2.20 Occupied Spaces (Areas)

The phrase "occupied space" within this specification refers to spaces that are occupied by unprotected non-remediation personnel while work is in progress. It also refers to areas adjacent to work areas that are not currently undergoing remediation.

1.2.21 Personal Protective Equipment (PPE)

Any material or device worn to protect a worker from exposure to, or contact with, any harmful material or force. PPE must be cleaned or disposed of prior to removal from the remediation work area.

1.2.22 Poly

Polyethylene sheet with a minimum thickness of 6 mils (IHFOM, CH 13, Sec. 3).

1.2.23 Porous Material

Permeable materials having the physical properties that allow liquids or gasses to pass through. These materials include but are not limited to the following: gypsum wall board, insulation, wallpaper, ceiling material, carpet, padding, paper goods (i.e., cardboard boxes, loose paper, books), stuffed furniture, wicker, fabrics.

1.2.24 Pressure Differential Measuring Instrument

Device used to measure the relative pressure difference between the work area/containment and areas outside the work area. For mold remediation, the device must measure accurately in the 0 to 0.04 inch of water range.

1.2.25 Semi-porous Material

A material that can absorb liquids if exposed over long periods of time. These materials include but are not limited to wood, concrete, linoleum, vinyl wall covering, wooden or hardboard furniture, plaster.

1.2.26 Ventilation System Mold Remediator (VSMR) Qualifications

An individual certified by the North American Duct Cleaning Association (NADCA) to clean HVAC systems.

1.2.27 Work Area

The area where remediation operations are actively performed and controlled to prevent the spread of dust / spores and entry by unauthorized personnel. A work area is the space, group of spaces, or the building, as defined by the Microbial Assessment Survey.

1.3 REQUIREMENTS

1.3.1 Description of Work

A mold remediation specification ~~will~~must be prepared by an independent third party, licensed NYS Mold Assessor ~~if this project is defined as a mold abatement per NYS 32 § 930-940~~. The remediation specification will include:

a. Provide mold remediation work including the handling and control of mold contaminated materials and the resultant procedures and equipment required to protect workers, the environment and occupants of the building or area, or both, from contact with mold products and spores. The work also includes the disposal of any mold contaminated materials generated by the work. The mold removal work includes the demolition and removal of ceiling tile, drywall and plaster. Provide containment and engineering control techniques as outlined in this specification. All mold contaminated material removal work must be supervised by a NYS mold supervisor as specified herein.

b. No work in this specification section can be provided by any person, contractor, or contracting entity involved in the preparation of the contract documents of which this specification section is a part.

c. The following microbial remediation specifications apply to the cleaning / removal and disposal of fungally-contaminated porous, semi-porous and non-porous surfaces within various types of structures. The level of containment and requirements for cleaning and remediation of materials will depend on the condition of the space and materials being remediated.

d. The NYS mold assessor must monitor the site on a daily basis while remediation work is in progress, identifying work and work practices that are not in compliance with the approved microbial remediation plan, and performing all inspections required by this specification. The Contracting Officer may require the removal of any individual for non-compliance with quality requirements specified in the contract.

e. This specification section includes the protocol regarding proper disposal of the removed building material components from within the work site.

f. Use proper cleaning procedures, engineering controls, and apply best management practices to remove microbial growth and spore fallout from all surfaces and building materials to minimize the further release of microbial spores. Address semi-porous and nonporous surfaces within the facility in each cleaning phase of the project. Damp wipe and

HEPA vacuum all surfaces, at a minimum. Remove and dispose of porous building materials that are supporting microbial growth.

1.3.2 Security Requirements

Prior to granting access to any work area (i.e., building, area, room, or space) for mold remediation work, a determination must be made by the government agency whether classified or controlled unclassified information (paper material or electronic media) or equipment is contained in the work area(s).

It may be necessary depending on the sensitivity of the work area or the information contained in the area to authorize the Government activity or tenant command responsible for the work area to provide their own appropriately cleared military or government personnel to properly remove or secure any classified or controlled unclassified information, electronic media or equipment located in their work area(s). Prior authorization would be required and the area would need to be evaluated to ensure it is safe for personnel to enter and all personnel must utilize the required PPE to safely enter the work area.

a. If Contractor personnel require access to classified information or spaces to perform mold remediation work, the Government must issue the Contractor facility a Facility Clearance Level (FCL) (Contract Security Classification Specification) prior to the initiation of the work under the contract. If the Contractor facility does not possess a valid FCL issued by the Defense Security Service (DSS), the Government will be required to submit a sponsorship request to DSS requesting that the Contractor be processed for and issued a current FCL at the appropriate level.

b. Access to classified information (paper material, electronic media, and equipment) must only be granted to authorized and appropriately cleared government and U.S. contractor personnel that possess a personnel security clearance commensurate with the level of information contained in the work area that requires a mold remediation effort.

c. Access to Controlled Unclassified information (i.e., For Official Use Only, Sensitive but Unclassified, Privacy Act Information, Export Controlled unclassified) can be granted to DOD cleared contractors, consultants and grantees that are conducting official business for the DOD or DON. Non-cleared U.S. contractor personnel who only require access to controlled unclassified information can be granted access if they get a favorable trustworthiness determination on an individual Favorable Tier 1 investigation and fingerprint result submitted on their behalf by the government agency issuing the contract.

d. Classified information and controlled unclassified information must be safeguarded / secured, reproduced, and destroyed in accordance with SECNAV M-5510.36.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance with

Section 01 33 29 SUSTAINABILITY REPORTING. Submittals with an "AE" are for submittal to the Designer of Record. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Ventilation System Mold Remediator (VSMR) Qualifications; G, RO

Mold Assessment Report; G, RO

Mold Remediation Plan written by a NYS Mold Assessor; G, RO

Respiratory Protection Program; G, RO

Worker Records;

NYS Mold Assessor License; G, RO

NYS Mold Remediation Supervisor Qualifications; G, RO

NYS Licensed Mold Remediation Contractor; G, RO

SD-03 Product Data

Disinfectants or Biocide Sanitizing Solutions; G, RO

Fungicidal Agents, (EPA); G, RO

Personal Protective Equipment (PPE); G, RO

Pressure Differential Measuring Instrument;

Safety Data Sheets (SDS) for All Materials; G, RO

Dehumidifiers;

Air Filtration Units;

SD-06 Test Reports

Licensed NYS Mold Assessor Daily Reports; G, RO

SD-11 Closeout Submittals

Submittals at Completion of Remediation Work; G, RO

1.4.1 Preconstruction Submittals

Within ~~10~~60 days from the award of the contract and prior to the start of the work, submit to the Contracting Officer six copies of the following items for review and permanent file.

1.4.1.1 Preliminary Mold Visual Assessment Report

A written report to document the pre-remediation condition of the work areas and the results of the HVAC systems inspection.

1.4.1.2 Mold Remediation Plan

Submit a job-specific, written plan approved by a licensed NYS mold assessorto the Contracting Officer for final approval prior to start of work. The plan must address the following items at a minimum:

a. Description of materials to be remediated, providing location and quantities and methods to be used for remediation according to the requirements of NYS 32 § 930-940.

b. Products: Disinfectants, detergents, biocides, sanitizing solutions, and fungicidal agents, (EPA).

c. Containment procedures to include description and locations of engineering controls and decontamination unit to include entry and exit procedures (provide sketch of floor plan showing location of containment barriers and decontamination units). Include locations of AFUs and AFU discharges to the outside.

d. Description of personal protective equipment to be used during the remediation.

e. Construction barricades and barriers in occupied areas.

f. HVAC Shut down and start-up procedures.

g. HVAC Evaluation and remediation procedures.

h. Moisture and relative humidity control procedures and equipment.

i. Packaging and disposal procedures.

j. Safety Precautions to include lockout / tag-out, fall protection, confined space entry procedures, and fire protection.

k. Description of the method to be employed to control cross contamination of areas not in the work area. Include a risk assessment related to the suitability of people to occupy areas adjoining the remediation area while remediation activities are ongoing.

l. IH Quality Control procedures to include visual inspection.

m. Procedures to control, abate, and dispose of Asbestos Containing Materials (ACM), Presumed Asbestos Containing Materials (PACM) and Lead Based Paint (LBP) coincident with microbial remediation. ACM, PACM, and LBP must be identified before work begins; Identify the presence, location, and quantity of ACM,PACM, and LBP therein pursuant to paragraphs (g),(k)(1) of 29 CFR 1926.1101 and for lead 29 CFR 1926.62. Both asbestos and lead must be removed prior to mold activities.

1.4.1.3 Respiratory Protection Program

Provide written copy of Contractor's Respiratory Protection program.

1.4.1.4 Worker Records

Provide the following documents for all workers, including supervisory

personnel. If new workers are added to the crew, provide the same documentation for them.

Employee Instruction and Release Form: Provide documentation showing that each employee has been instructed on the following items:

a. Use and fit of respirators (for employees entering and working in the containment).

b. Protective clothing.

c. Protective measures.

d. Safety and Emergency Egress Procedures.

e. Site specific fall protection plan and training.

f. Microbial remediation hazards and practices including engineering controls and isolation. Training should include "hands on" training for microbial remediation supervisors.

g. Workers' release forms stating the potential hazards involved with the scope of the work.

Worker Training Certification: Submit copies of training certificates for each employee indicating that the employee has received training at the appropriate level for the work prescribed in the description of work.

1.4.1.5 Certified Industrial Hygienist (CIH)/Licensed NYS Mold Assessor Qualifications

Submit the name, address, and telephone number of the Certified Industrial Hygienist (CIH) and NYS Mold Assessor License. Provide copies of board certificates, resume to document field experience, and evidence that the CIH and Licensed NYS Mold Assessor have successfully completed training in microbial investigation and remediation.

1.4.1.6 NYS Mold Remediation Supervisor Qualifications

Onsite supervisor must be a Licensed NYS Mold Supervisor employed by a firm licensed to perform mold abatement and have one of the following certifications: Certified Microbial Remediator (CMR), Certified Microbial Remediation Supervisor (CMRS), or Applied Microbial Remediation Specialist (AMRS). Submit copies of supervisory training certificates.

1.4.2 Product Data

Within 10 days of contract award, submit product data for items identified for use in Mold Remediation Plan.

1.4.3 Licensed NYS Mold Assessor Daily Reports

Prepare a written Daily Report for each day that microbial remediation work is being accomplished. Submit the Licensed NY Mold Assessor Daily Reports to the Contracting Officer by 1000 hours of the following day. The Daily Report at a minimum must include measurements of differential pressure and temperature and relative humidity in work areas, and detail any non-compliance issues observed.

1.4.4 Submittals at Completion of Remediation Work

Within 14 days of completion, provide the following information:

a. Daily Project Logs.

b. Licensed NYS Mold Assessor Daily Reports.

c. Photographic Logs.

d. Contractor's Licensed NYS Mold Assessor Report certifying the microbial remediation is complete.

1.5 RECORD KEEPING

A Daily Project Log must form a permanent record of the project. Secure and maintain these logs and any other required documentation as part of the permanent project file.

1.5.1 Daily Project Log

The Mold Remediation Supervisor must maintain a Daily Project Log. The Daily Project Log must be used each day of the project to document the following information.

a. Date.

b. Name of Mold Remediation Supervisor.

c. Name of Licensed NYS Mold Assessor monitoring work area.

d. Number of workers on site.

e. Equipment utilized.

f. Brief description of daily work activities.

g. Listing of any non-compliance noted, emergencies, stop work orders (with detailed explanation),e.g.: exhaust system pressure differential recordings and descriptions of any other significant events.

PART 2 PRODUCTS

2.1 DISINFECTANTS, BIOCIDES, SANITIZING SOLUTIONS AND FUNGICIDAL AGENTS, (EPA)

Must be EPA Registered for the use detailed in the Mold Remediation Plan and used in accordance with the manufacturer's specifications. Provide SDS sheets to the Contracting Officer for any chemicals that will be used during the performance of the work for approval.

2.2 HAZARD COMMUNICATION

Adhere to all parts of 29 CFR 1926.59 and provide the Contracting Officer with a copy of the Safety Data Sheets (SDS) for all materials brought to the site.

PART 3 EXECUTION

3.1 EQUIPMENT

Provide manufacturer's certificate of compliance for all equipment used to contain the microbial contamination.

3.1.1 Respirators

Select respirators from those approved by the National Institute for Occupational Safety and Health (NIOSH), Department of Health and Human Services. Provide personnel engaged in set-up, pre-cleaning, cleanup, handling, and removal of contaminated materials with the appropriate respiratory protection as specified in 29 CFR 1910.134. Mold remediation plan must consider Table 17.1 in AIHA IMOM08-679 "Recognition, Evaluation, and Control of Indoor Mold", which lists the minimum levels of respiratory protection based on the activity and size of the remediated area.

3.1.2 Protective Clothing

Provide all workers with protective clothing as appropriate for the work being accomplished, as required by the Mold Remediation Plan.

3.1.3 Warning Signs and Labels

Provide bilingual warning signs printed in English and Spanish at all approaches to the work areas IICRC S500 and NYS 32 § 930-940. Locate signs at such a distance that personnel may read the sign and take the necessary protective steps required before entering the area. Warning signs may be in the form of continuous plastic tape.

3.1.4 Dehumidifiers

Install and use dehumidifiers as needed during the remediation to maintain relative humidity below 60 percent in the work area. Drain the condensate water to a permanent drain, or empty as needed to prevent water overflowing from the dehumidifiers.

3.1.5 Air Filtration Units (AFU)

Install and use AFUs with HEPA filters, and manufacturer specified pre-filters, as part of the exhaust ventilation system to develop and maintain the specified desired air pressure differential inside the enclosed work area relative to the outside areas. Acquire and pay for any licenses needed for use of any equipment, including but not limited to, air pressure differential systems and air filtration systems.

a. Replace HEPA filters and pre-filters for AFUs as required to maintain pressurization performance requirements during demolition and cleaning. Do not reuse filters. Bag used filters at a minimum in clear 6 mil polyethylene bags within the containment and disposed as contaminated waste.

b. Discharge air from any AFUs located in the work area containment to the outside environment when creating a negative pressure containment to create a negative pressure relative to the outside and adjacent work areas not undergoing active remediation of 0.02 inch H2O to 0.04 inch H20. Discharge air in excess of that required for creating the proper negative pressure to the work area. The AFUs must provide four

to six air changes per hour in the work area. Under no circumstances may air from AFUs discharge to an occupied area. Coordinate location of window sashes or doors required for discharge openings with the Contracting Officer. Exhaust discharge openings may be constructed of plywood, and the seals around such opening must be airtight.

c. Seal all exhaust and intake openings in AFUs with one layer of 6 mil polyethylene sheeting when not in use.

3.1.6 Vacuum Cleaners Equipped with HEPA Filters

Provide vacuum cleaners equipped with HEPA filters designed for continuous operation in order to complete the work in a timely and efficient manner.

a. Provide nozzle attachments as required to adequately remove all dust. As a minimum, nozzle attachments must include crevice and extended bristle brush nozzles. Any vacuum that is not equipped with a HEPA filter must not be used at anytime.

b. Provide sufficient vacuum cleaners equipped with HEPA filters designed for continuous operation in the work area during mold remediation inside the containment area.

c. Provide additional vacuum cleaners equipped with HEPA filters in the enclosed work area during remediation or cleaning work as required by the size (area) of the containment and to maintain timely progress of the work.

3.2 GENERAL REQUIREMENTS

3.2.1 Pre-Mold Remediation Work Conference

Meet with the Contracting Officer prior to beginning work to discuss in detail the Mold Remediation Plan, including work procedures and safety precautions. Once approved by the Contracting Officer, the plan will be enforced as if a part of this specification. Any variances to the specification as a result of the plan must be specifically identified to allow for free discussion and approved by the Contracting Officer in writing prior to starting work. Before work in areas with Asbestos Containing Materials (ACM), Presumed Asbestos Containing Materials (PACM) and Lead begins, identify the presence, location, and quantity of ACM, PACM and Lead. Ensure proper notification of regulatory authorities. Consult with Contracting Officer to obtain facility ACM / LBP surveys. Mitigate any disturbance of painted/coated surfaces in accordance with 29 CFR 1926.62, 29 CFR 1926.1126 and 29 CFR 1926.1127.

3.2.2 Containment Entry / Exit Procedure

Ensure that each worker and authorized visitor follows entry and exit procedures detailed in the Mold Remediation Plan.

3.3 REMOVAL PROCEDURES

3.3.1 Protection of Existing Work Areas

Perform work in a manner to minimize the damage or contamination to areas outside or directly adjacent to the work area. Inspect areas inside and outside proposed work areas to identify existing damage and notify Contracting Officer prior to start of work.

Where materials outside work area are damaged or contaminated as a result of the Contractors work efforts as verified by the Contracting Officer using visual inspection or sample analysis, it must be restored to its original condition or decontaminated by the Contractor at no expense to the Government as deemed appropriate by the Contracting officer. Should adjacent or outside areas become contaminated as a result of the Contractors work efforts, stop work immediately. Clean the newly contaminated areas at no additional expense to the Government. The work may proceed at the discretion of the Contracting Officer once the area has been verified by visual inspection as restored.

3.3.2 Remediation of Fungally Contaminated Building Materials

The removal of contaminated materials must follow in general the listed sequence of work. The Contractor may make changes to improve work flow with the approval of the Contracting Officer.

a. Provide level of containment and PPE required by the Mold Remediation Plan that will be developed by a Licensed NYS Mold Assessor.

b. Disable all HVAC units and exhaust fans in the area to be remediated. Cover and seal all supply vents, return vents, and air handling units in the project area using two layers of 6 mil poly.

c. Protect materials to remain in work area. Where possible, clean all materials to be salvaged in place to prevent possible cross-contamination created by moving materials through non-remediation areas.

d. Remove undamaged items and materials to be cleaned and salvaged from the work area. Store materials in an area with relative humidity maintained below 60 percent and where temperatures will not damage the material. Notify Contracting Officer of existing damage to items prior to removal.

e. Set up containments, including protection of materials remaining within the containment and AFUs. Notify Contracting Officer that the area is prepared for remediation activities.

f. Pre-demolition inspection by the NYS Licensed Mold Assessor.

g. Demolition and removal / cleaning of contaminated materials.

h. Post-remediation inspection by the NYS Licensed Mold Assessor.

i. Perform final cleaning in the containment.

j. Remove/demolish all carpet.

k. Clearance inspection by the NYS Licensed Mold Assessor.

l. Duct and HVAC cleaning, if necessary.

m. Deconstruction of containment, removal of AFUs.

n. Return items that were previously removed and cleaned to the occupied area.

3.3.3 Remediation Procedures

3.3.3.1 Remediation of Non-Porous Materials

Method of remediating non-porous items:

a. HEPA vacuum all surfaces.

b. Damp wipe all surfaces using clean water or a detergent solution.

c. Ensure all cleaned surfaces are dried thoroughly.

3.3.3.2 Porous Materials

a. Ceiling Tile: Remove/demolish all ceiling tile.

(1) Removal: Remove ceiling tile that has remained wet for 48-hours or longer, or has visible mold growth (AIHA IMOM08-679). If ceiling tile has dried out lightly mist before removal.

c. Textiles

(1) Discard textiles with visible mold growth.

(2) Clean textile based items, including clothing, linens, and toys that do not have visible mold growth, but have been wet, in standard commercial or residential washing machines with standard washing machine detergent.

(3) Dry all items completely before returning to the building / house.

(a) When possible, use dryers to dry items.

(b) If dryers will cause irreversible harm to the item, hang the item on a drying rack in a temperature and humidity controlled space. Discard items not dry within 48-hours (AIHA IMOM08-679).

d. Upholstered Furniture

(1) Removal: Discard upholstered furniture that has remained wet for 48-hours or longer (AIHA IMOM08-679), or that have visible mold growth.

(2) Cleaning: Clean upholstered furniture that has been exposed to mold spores but does not have visible mold growth by HEPA vacuuming upholstery and wood or metal structure, followed by a damp wipe of semi-porous or non-porous portions of the furniture. Dry furniture thoroughly after cleaning.

3.4 DETAILED SEQUENCE OF WORK FOR MOLD REMOVAL UNDER CONTAINMENT (If Required)

3.4.1 Preparation for Remediation Work

a. Provide level of containment and PPE required for the remediation based on the Mold Remediation Plan.

b. Disable all HVAC units and exhaust fans in the area to be remediated.

c. Remove undamaged materials from the work area if they are to be salvaged but cannot be cleaned in place. Store materials in an area with relative humidity maintained below 60 percent and where temperatures will not damage the material. Notify Contracting Officer of existing damage to items prior to removal. Clean materials using procedures detailed in Remediation Procedures.

d. Remove supply diffusers, return grilles and exhaust grilles. Clean diffusers and grilles using procedures detailed in Remediation Procedures.

e. Construct containment barriers. Existing walls can be used as a portion of the containment barriers if existing openings in walls (such as doors, wall openings, vents) are sealed using 6 mil polyethylene.

f. Install the AFUs and dehumidifiers.

g. Seal supply, return, and exhaust openings with 6 mil polyethylene sheeting and protect intakes to air handling units. Air handling units are to remain off.

h. Install all equipment needed for removal work in the containment area to minimize egress during demolition.

i. The Contracting Officer will inspect the containment to verify that the containment is properly constructed and the containment area has an overall negative pressure of 0.02 to 0.04 inch water column relative to the outside and adjacent work areas not undergoing active remediation, prior to beginning demolition work.

3.4.2 Demolition

a. Remove mold contaminated materials to be discarded, such as paper, and furniture. Double bag material in 6 mil poly bags. Seal poly bags using duct tape inside the containment. HEPA vacuum bags before removing them from the containment or airlock. When possible, pass the bags directly from the containment or airlock to the outside. Transport bags to a dumpster. Do not leave the bags at the building / house.

b. Lightly mist all contaminated materials that are being discarded to minimize generation of airborne mold spores during demolition/removal.

c. Use dust collection attachments on all power tools, such as sanders, saws, to capture dust created when using the tools. Outlet of dust collector should discharge into inlet of AFU.

d. If wood studs are contaminated, HEPA vacuum all surfaces, scrub them with a brush and detergent to remove mold. After scrubbing studs, HEPA vacuum again to remove any remaining dust. Replace wood studs with damage severe enough to reduce the structural capacity of the member. Prior to removal of any structural member consult with the Contracting Officer.

e. Clean all metal framing with a dilute detergent solution. Clean metal framing with light rust using steel wool and coat with a rust inhibiting paint. Replace metal framing with rust damage severe enough to reduce the structural capacity of the member. Prior to

removal of any structural material, consult with the Contracting Officer.

f. Remove contaminated carpet scheduled for removal.

g. Place removed carpet and remaining debris in two layers of 6 mil poly bags. Seal poly bags using duct tape inside the containment. HEPA vacuum bags before removing them from the containment or airlock. When possible pass the bags directly from the containment or airlock to the outside. Transport bags to a dumpster. Do not leave the bags at the building .

h. Remediation workers must HEPA vacuum their PPE, then remove their PPE within the airlock chamber. Discard disposable coverall suits into a 6 mil poly bag.

3.4.3 Post-Demolition Inspection

a. An independent, third-party NYS Licensed Mold Assessor (hired by the government) will inspect the containment area to verify that all contaminated materials have been removed.

b. Allow a minimum of 12-hours after completion of removal work, with AFUs operating, for airborne dust in the containment to settle or be removed by the AFUs.

3.4.4 Cleaning after Demolition, and Cleaning of Settled Spores from Porous / Non-Porous Materials

a. Continue to operate AFUs during cleaning.

b. Clean exposed surfaces.

(1) HEPA vacuum all surfaces.

(2) Damp wipe all non-porous exposed surfaces including polyethylene sheets used to protect materials, external surfaces of ductwork, studs, and floors with clean rag and clean potable water or detergent solution.

(3) Remove poly sheeting inside the containment.

(4) HEPA vacuum all surfaces protected by poly sheeting.

(5) Damp wipe non-porous surfaces protected by poly sheeting with clean water or a detergent solution.

c. Final clearance inspection will be conducted by an independent, third-party NYS Licensed Mold Assessor (hired by the government). Clearance inspections will be performed using the procedures detailed in Post-Remediation Inspection. If areas fail final clearance inspections, additional corrective actions taken by the contractor will be at no additional cost to the Government. Maintain containments in place until spaces are inspected and accepted by the Government as being fully remediated. The independent, third-party NYS Licensed Mold Assessor will determine whether additional cleaning is required by the Contractor and whether the clearance process will be repeated.

3.5 FIRE PROTECTION

Provide portable fire extinguishers within the containment area and outside the decontamination unit. Fire extinguishers Must be rated for the class of fire hazards in the work area and must be sized for coverage of the areas within the containment. At a minimum, one 10 pound ABC fire extinguisher for every 1,000 square feet must be strategically placed around the containment. Personnel must be trained for emergency egress and the use of fire extinguishers. Notify fire officials of work activities as required.

3.6 CONSTRUCTION BARRIERS

a. Provide interior shoring, bracing, or support to prevent movement, settlement, or collapse of structure or element to be demolished and adjacent facilities or work to remain. Shoring, bracing or support will be necessary when structural wood studs or metal framing need to be removed and replaced when they cannot be cleaned.

b. Do not disturb mold-contaminated building materials while isolating work areas. This precaution prevents the release of mold spores.

c. Workers must wear respirators and other PPE as outlined in the mold remediation plan when installing critical barriers where mold contaminated surfaces (walls or surfaces with visible settled dusts) are likely to be disturbed. Operate an AFU if disturbance is likely during setup.

d. Monitor the air pressure differential across work area containments. The monitoring system must be in place before the start of remedial activities. Verification by the NYS Licensed Mold Assessor is required prior to the start of the mold remediation.

3.7 QUALITY ASSURANCE / QUALITY CONTROL REQUIREMENTS

3.7.1 Contractor Qualifications

Work must be performed by a NYS Licensed Mold Remediation Contractor. Contractor must carry insurance that specifically covers mold remediation.

a. Remediation contractor's on-site supervisor must have one of the following certifications: NYS Licensed per NYS 32 § 930-940.

b. Mold remediation workers must be given training in PPE and mold remediation activities as required for their particular job. Mold remediation plan must provide details of worker training.

3.7.2 Waste Management and Removal

Keep the site and work area free from accumulations of dust, waste materials, or rubbish caused by Contractor operations and free from any flammable materials or other sources of fire hazard. Remove all waste materials and rubbish from and about the work site in strict accordance with the specifications and applicable codes and regulations.

3.7.3 Post-Remediation Inspection

Clean up all debris and dust in interior spaces outside the work area resulting from the Contractor's remediation work.

After all visible accumulations of material and debris are removed from the containment, provide the NYS Licensed Mold Assessor a 24-hour notice for a final clearance visual inspection. The NYS Licensed Mold Assessor must conduct a thorough visual inspection of the work area. If during this inspection any visible debris or mold contamination are observed, the Contractor must re-clean the work area without additional cost to the Government.

3.7.3.1 Clearance

a. Clearance Criteria

Clearance will be based on visual assessment (all visible mold removed, all visible dust removed, based on a "white glove" test) by Contracting Officer. "White glove" test will consist of wiping the surface with a clean cloth of color suitable to reveal expected type of dust. For most surfaces, a white cloth is suitable. In addition, non-viable air samples collected inside containment and ambient air will be used as clearance. Inside concentrations must be at least 90% less than outside air. In addition, containment air must not include any high concentrations of the dominant species detected in the Mold Assessment Report.

b. Failed remediation areas will be recleaned at no additional cost to the Government and the AFUs kept in operation another 12-hours, followed by another visual assessment. Subsequent failures will follow the same routine until a pass condition is secured.

3.8 CLEAN-UP AND DISPOSAL

3.8.1 Disposal of Material

Dispose of contaminated bagged waste materials removed during this remediation as general construction debris. Follow all applicable local, State, and Federal requirements for the disposal of this material.

3.8.2 Material Packaging

Place waste, as waste is removed, into a disposal container promptly. Disposal containers must consist of at a minimum, two layers of clear 6 mil polyethylene bags. Tape bags in a gooseneck fashion to form an airtight seal and label appropriately. Bag waste from vacuums equipped with HEPA filters in 6 mil polyethylene bags.

3.8.3 Building Exit (Waste Disposal)

HEPA vacuum and damp wipe bags of contaminated waste material prior to removal from the building.. When possible pass the bags directly from the containment or airlock to the outside. Transport bags to a dumpster.

3.8.4 Hazardous Material

Should the Contractor encounter any hazardous materials, notify the NYS Licensed Mold Assessor immediately for direction.

-- End of Section --

SECTION 07 27 36

SPRAY FOAM AIR BARRIERS AND INSULATION
05/17

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR BARRIER ASSOCIATION OF AMERICA (ABAA)

ABAA Accreditation	Accreditation
ABAA QAP	Quality Assurance Program

AMERICAN SOCIETY OF SAFETY PROFESSIONALS (ASSP)

ASSP Z9.2	(2018) Fundamentals Governing the Design and Operation of Local Exhaust Ventilation Systems
ASSP Z88.2	(2015) American National Standard Practices for Respiratory Protection

ASTM INTERNATIONAL (ASTM)

ASTM C518	(2017) Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
ASTM C1029	(2015) Standard Specification for Spray-Applied Rigid Cellular Polyurethane Thermal Insulation
ASTM C1303/C1303M	(2015) Standard Test Method for Predicting Long-Term Thermal Resistance of Closed-Cell Foam Insulation
ASTM C1338	(2014) Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings
ASTM D1621	(2016) Standard Test Method for Compressive Properties of Rigid Cellular Plastics
ASTM D1622	(2014) Apparent Density of Rigid Cellular Plastics
ASTM D1623	(2017) Standard Test Method for Tensile and Tensile Adhesion Properties of Rigid Cellular Plastics

ASTM D2126	(2009) Response of Rigid Cellular Plastics to Thermal and Humid Aging
ASTM D2842	(2012) Water Absorption of Rigid Cellular Plastics
ASTM D4541	(2017) Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
ASTM D6226	(2015) Standard Test Method for Open Cell Content of Rigid Cellular Plastics
ASTM E84	(2020) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E96/E96M	(2016) Standard Test Methods for Water Vapor Transmission of Materials
ASTM E119	(2020) Standard Test Methods for Fire Tests of Building Construction and Materials
ASTM E283	(2019) Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
ASTM E736	(2000; R 2011) Cohesion/Adhesion of Sprayed Fire-Resistive Materials Applied to Structural Members
ASTM E2178	(2013) Standard Test Method for Air Permeance of Building Materials
ASTM E2357	(2017) Standard Test Method for Determining Air Leakage of Air Barrier Assemblies

ICC EVALUATION SERVICE, INC. (ICC-ES)

ICC-ES AC377	(2016) Acceptance Criteria for Spray-Applied Foam Plastic Insulation

INTERNATIONAL CODE COUNCIL (ICC)

ICC IBC	(2018) International Building Code
ICC IECC	(2015) International Energy Conservation Code

INTERNATIONAL SAFETY EQUIPMENT ASSOCIATION (ISEA)

ANSI/ISEA Z87.1	(2020) Occupational and Educational Personal Eye and Face Protection Devices

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 10	(2018; ERTA 1-2 2018) Standard for Portable Fire Extinguishers
NFPA 31	(2020) Standard for the Installation of Oil-Burning Equipment
NFPA 54	(2018) National Fuel Gas Code
NFPA 70	(2020; ERTA 20-1 2020; ERTA 20-2 2020; TIA 20-1; TIA 20-2; TIA 20-3; TIA 20-4) National Electrical Code
NFPA 275	(2017) Standard Method of Fire Tests for the Evaluation of Thermal Barriers
NFPA 285	(2012) Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Non-Load-Bearing Wall Assemblies Containing Combustible Components

SPRAY POLYURETHANE FOAM ALLIANCE (SPFA)

SPFA TechDocs	(2015) SPFA Technical Documents Library, four categories: General, Insulation, Roofing, Specialty

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-600-01	(2016; with Change 3, 2019) Fire Protection Engineering for Facilities

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.132	Personal Protective Equipment
29 CFR 1910.133	Eye and Face Protection
29 CFR 1910.134	Respiratory Protection

UNDERWRITERS LABORATORIES OF CANADA (ULC)

ULC S705.2	(2005) Standard for Thermal Insulation - Spray Applied Rigid Polyurethane Foam, Medium Density - Application

1.2 RELATED REQUIREMENTS

Coordinate the requirements of ~~Section 07 27 10.00 10 BUILDING AIR BARRIER SYSTEM, SECTION 07 27 26 FLUID-APPLIED MEMBRANE AIR BARRIERS,~~this specification and other building envelope sections to provide a complete air barrier system within the area of spray foam installation. Submit all materials, components, and assemblies of the air barrier system together as one complete submittal package.

1.3 DEFINITIONS

1.3.1 Long Term Thermal Resistance (LTTR)

The thermal resistance value of a closed cell foam insulation product measured using accelerated aging ASTM C1303/C1303M equivalent to the time-weighted average thermal resistance value over 15 years. Loss in thermal resistance is attributable to changes in cell gas composition caused by diffusion of air into and blowing agent out of the foam cells.

1.3.2 SPFA TechDocs

Reformatted documents, named SPFA TechDocs (http://www.sprayfoam.org/technical/spfa-technical-documents), places each document in one of four categories for easy reference and identification: Roofing, Insulation, Specialty and General.

Spray Polyurethane Foam: Thermal and air/vapor barrier system consisting of sprayed polyurethane foam (SPF).

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals with an "AE" are for submittal to the Designer of Record. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Qualification of Manufacturer; G, RO

Qualification of Installer; G, RO

Quality Control Plan; G, RO

Safety Plan; G, RO

Fire Prevention Plan; G, RO

Respirator Plan; G, RO

SD-02 Shop Drawings

Spray Foam Air Barrier System

Foam Air Barrier System; G, RO

Fire-Rated Assemblies; G, RO

SD-03 Product Data

Closed Cell SPF; G, RO

~~Transition Membrane; G, RO~~

Primers, Adhesives, and Mastics; G, RO

Sealants; G, RO

Safety Data Sheets; G, RO

Thermal Barrier Materials; G, RO

Ignition Barrier Coatings; G, RO

Accessories; G

~~Recycled Content for Closed Cell Spray Foam Air Barrier; S~~

~~Recycled Content for Open Cell Spray Foam Air Barrier; S~~

SD-04 Samples

Spray Foam Air Barrier Mockup; G, RO

SD-06 Test Reports

Field Peel Adhesion Test; G, RO

~~Thermographic Test; G, RO~~

~~Air Barrier Test; G, RO~~

Primers; G, RO

Fire-Ratings Of ThermalIgnition Barrier Materials; G, RO

Flame Spread And Smoke Developed Index Ratings Of SPF Products; G, RO

Flame Propagation Of Wall Assemblies; G, RO

Site Inspections Reports; G, RO

SD-07 Certificates

Closed cell SPF; G, RO

~~Transition Membrane; G, RO~~

Indoor Air Quality for Spray Foam Air Barrier; S

SD-08 Manufacturer's Instructions

SPF Handling, Storage, and Spray Procedures; G, RO

Substrate Preparation; G, RO

Thermal Barrier; G, RO

Ignition Barrier; G, RO

~~Transition Membrane; G, RO~~

Primers, Adhesives, and Mastics; G, RO

SD-09 Manufacturer's Field Reports

Core Samples; G, RO

Daily Work Record; G, RO

~~Visual Inspection and Thermal Scanning; G, RO~~

\1.5 MISCELLANEOUS REQUIREMENTS

For the spray foam air barrier system provide the following:

1.5.1 Shop Drawings

Submit spray foam air barrier shop drawings showing locations, detailing, and extent of spray foam air barrier assemblies. Provide details of all typical conditions, intersections with other envelope assemblies and materials, membrane counter-flashings. Provide details for fire-rated assemblies and indicate materials for thermal barriers and ignition barrier s. Show details for bridging of gaps in construction, treatment of inside and outside corners, expansion joints, methods of attachment of materials covering the SPF without compromising the barrier. Indicate how miscellaneous penetrations such as conduit, pipes, electric boxes, brick ties, and similar items will be sealed.

1.5.2 Product Data

Submit manufacturer's technical data indicating compliance with performance and environmental requirements, manufacturer's printed instructions for evaluating, preparing, and treating substrates, temperature and other limitations of installation conditions, safety requirements for installation, and Safety Data Sheets. Indicate flame and smoke spread ratings for all products. Submit thermal barrier and ignition barrier literature including material description, physical properties, and fire-ratings.

1.5.3 Mockup

Provide a mockup of each foam system specified. Apply foam in an area designated by the Contracting Officer. Apply an area of not less than 50 square feet. Include all components specified for the finished assembly including primers, support components, expansion and contraction joints, ignition barriers, thermal barriers, and other accessories as representative of the complete system. Isolate the area and protect workers as required by 29 CFR 1910.132, 29 CFR 1910.133 and 29 CFR 1910.134. Notify the Contracting Officer a minimum of 48 hours prior to the test application. Select a test area representative of conditions to be sprayed including window or door openings, wall to ceiling transitions, flashings, and penetrations, as applicable.

1.5.4 Test Reports

Submit test reports indicating that field peel adhesion tests on all materials have been performed and the changes made, if required, in order to achieve successful and lasting adhesion. Submit test reports for flame spread and smoke developed index ratings of SPF products tested in accordance with ASTM E84. Submit test reports for flame propagation of wall assemblies tested in accordance with NFPA 285. Submit test reports for fire-ratings of thermal ignition barrier materials tested in

accordance with ASTM E84.

1.6 DELIVERY, STORAGE, AND HANDLING

1.6.1 Delivery

Deliver and store materials in sufficient quantity to allow for uninterrupted flow of work. Inspect materials delivered to the site for damage; unload and store out of weather. Deliver materials to the jobsite in their original unopened packages, clearly marked with the manufacturer's name, brand designation, description of contents, and shelf life of containerized materials. Store and handle to protect from damage. Submit SPF Handling, Storage, and Spray Procedures in accordance with submittal procedures.

1.6.2 Storage

Store materials in clean, dry areas, away from excessive heat, sparks, and open flame. Maintain temperatures in the storage area below the materials' flash point(s) and within limits recommended by the manufacturer's printed instructions. Provide ventilation in accordance with ASSP Z9.2 to prevent build-up of flammable gases. Store MDI (A-side) drums in locations that limit the risk of contact with water, acids, caustics (such as lye), alcohols, and strong oxidizing and reducing agents.

1.6.3 Handling

Handle materials and containers safely and in accordance with manufacturer's recommendations. Store liquids in airtight containers and keep containers closed except when removing materials. Do not use equipment or containers containing remains of dissimilar materials. Do not expose foam component containers to direct sunlight. Do not use materials from containers with content temperatures in excess of 80 degrees F.

Containers exposed to long periods of cold may also exhibit separation and poor performance. Do not use materials exposed to temperature ranges outside of manufacturer's instructions for exposure limits.

Mark and remove from job site materials which have been exposed to moisture, that exceed shelf life limits, or that have been exposed to temperature extremes.

1.6.3.1 Venting and Handling of Material Containers

Partially unscrew material container and drum caps to gradually vent the containers prior to opening. Do not inhale vapors. Decontaminate empty component containers by filling with water and allowing to stand for 48 hours with bung caps removed. Do not, under any circumstances seal, stop, or close containers which have been emptied of foam components.

1.7 FIELD PEEL ADHESION TEST

Perform a field peel adhesion test on the construction mockup. Test the SPF for adhesion in accordance with ASTM D4541 using a Type II pull tester except use a disk that is 4 inches in diameter and cut through the membrane to separate the material attached to the dish from the surrounding material. Perform test after curing period in accordance with manufacturer's written recommendations. Record mode of failure and area

which failed in accordance with ASTM D4541. Compare adhesion values with the manufacturer's established minimum values for the particular combination of material and substrate. Indicate on the inspection report whether the manufacturer's requirement has been met. Where the manufacturer has not declared a minimum adhesion value for their product and substrate combination, the inspector must record actual values.

1.8 SAFETY PROVISIONS

1.8.1 Fire Prevention

Provide a written fire prevention plan for the SPF application. Address specific fire hazards such as spontaneous combustion from exothermic heat build-up of SPF components during curing. Provide a continuous fire watch during mixing and spraying of SPF and for a minimum of 30 minutes after completion of work at the end of each day. Maintain fire watch for additional time as required to ensure no potential ignition conditions exist.

1.8.1.1 Fire Extinguishers

Furnish two fire extinguishers of minimum 15 pounds capacity each, in accordance with NFPA 10, in the immediate vicinity of the work. CAUTION: Do not discharge high pressure carbon dioxide extinguishers where explosive vapors exist since the discharge can cause a spark which will ignite the vapors.

1.8.2 Respirator Plan

Provide a written respirator plan in accordance with OSHA regulations that protects installers during application and addresses separation of the area to prevent other workers from entering the work area during spraying.

1.8.3 Isolation

Isolate the work area as recommended by spray foam manufacturer's written requirements. Prevent workers without respiratory, skin, and eye Personal Protective Equipment (PPE) or training from entering the work area or otherwise being exposed to off-gassing of the insulation in excess of permissible exposure limits.

1.8.4 Respirators and Eye Protection

Respiratory protective devices (respirators) must meet the requirements of ASSP Z88.2. Eye and face protective equipment must meet the requirements of ANSI/ISEA Z87.1. Additionally, sprayers and workers in the immediate vicinity of the spray must wear NIOSH-approved, full-face, supplied air respirators (SAR) operated in positive pressure or continuous flow mode. Workers not in the immediate vicinity of the sprayer must wear air purifying respirators (APR) with an organic gas / P100 particulate cartridge. Instruct personnel in the use of devices. Maintain such equipment and inspect regularly. All workers are required to have undergone pulmonary function testing and fit testing and must provide certification that they have done so. Change APR cartridges in accordance with manufacturer's written recommendations.

1.8.5 Clothing and Gloves

Sprayers and workers must wear protective clothing and gloves in

accordance with OSHA requirements during materials application. Disposable coveralls must be worn and must cover all exposed skin. Sprayers and workers must wear fabric gloves coated with nitrile, neoprene, butyl or PVC.

1.8.6 Additional Requirements

Require personnel to review the Health, Safety and Environmental Aspects of Spray Polyurethane Foam and Coverings published by the Spray Polyurethane Foam Alliance (SPFA). Verify compliance prior to allowing personnel on site for installation work. http://www.sprayfoam.org.

1.9 QUALITY ASSURANCE

1.9.1 Qualification of Manufacturer

Submit documentation verifying that the manufacturer of the SPF is currently accredited by the Air Barrier Association of America (ABAA Accreditation https://www.airbarrier.org/) and by the Spray Polyurethane Foam Alliance (SPFA).

1.9.2 Qualification of Installer

Submit documentation verifying that installers of the spray foam air barrier are currently certified by ABAA/BPQI (Building Performance Quality Institute) and by the Spray Polyurethane Foam Alliance (SPFA) Professional Certification Program (PCP). Installers must provide photo identification certification cards for inspection upon request.

1.9.3 General Quality Requirements

Provide all products and installation in accordance with SPFA TechDocs requirements (http://www.sprayfoam.org/technical/spfa-technical-documents) and documented best practices.

1.10 PRECONSTRUCTION MEETING

Conduct a preconstruction meeting after approval of submittals and a minimum of two weeks prior to commencing work specified in this Section. Attendance is required by the Contracting Officer's designated personnel, Contractor, and representatives of related trades including covering materials, substrate materials, adjacent materials, and materials and components of the air/vapor/thermal barrier system. Agenda must include, at a minimum, the following items:

a. Drawings, specifications and submittals related to the SPF work;

b. Sequence of construction;

c. Coordination with substrate preparation work and responsibility of repairing defects in substrates. Determine method of ensuring SPF work does not begin until substrates have been inspected and accepted;

d. Compatibility of materials;

e. Construction and testing of construction mockup;

f. Application of self-adhering air barrier transitions strips and primer as required for sealing the spray foam air barrier system at openings

including but not limited to windows, doors and louvers;

g. Spray foam air barrier system installation; including methods to be used to provide a continuous barrier at thru-wall flashing, penetrations, and covering of embed items;

h. Quality control plan including methods of applying the product so that a consistent thickness across the face of the substrate is achieved.

i. Procedures for SPF manufacturer's technical representative's onsite inspection and acceptance of substrates, contact info for the representative, frequency of visits, and distribution of copies of inspection reports. Determine where core samples will be taken and review procedures for daily documentation of SPF application.

j. Property protection measures, including isolation of the work, and prevention of overspray and clean-up should overspray occur.

k. Safety requirements, including review of PPE, fire prevention, safety plan, respirator plan, ventilation and separation of the work area, fall protection, and posting of warning signs. Provide a complete schedule and a detailed, written fire protection plan including temporary isolation of the product and the work area until permanent isolation or thermal barrier is in place.

1.11 ENVIRONMENTAL CONDITIONS

1.11.1 Temperature and Weather

Install SPF within the range of ambient and substrate surface temperatures in accordance with manufacturer's written instructions. Do not apply SPF to damp or wet substrates. Do not apply SPF during inclement weather or when ice, frost, surface moisture, or visible dampness is present on surfaces to be covered, or when precipitation is imminent. Do not apply SPF to exterior building surfaces when wind speeds exceed 25 miles per hour. Use moisture measuring methods and equipment to verify that the moisture conditions of substrate surfaces are in accordance with SPF manufacturer requirements prior to application. Substrate temperatures must be within limits recommended by the manufacturer's printed instructions.

1.11.2 Conditions for Primers

Follow manufacturer's printed application and curing instructions. Do not apply primer when ambient temperature is below 40 degrees F or when ambient temperature is expected to fall below 35 degrees F for the duration of the drying or curing period.

1.11.3 Conditions for Ignition Barriers

Ensure that sprayed surfaces comply with manufacturer's written requirements for application coverage, thickness, and curing prior to application of ignition barrier coatings.

1.11.4 Temporary Ventilation

Provide temporary ventilation for work of this section in accordance with manufacturer's written instructions and with OSHA requirements for this type of application.

1.12 FOAM SPRAY EQUIPMENT

1.12.1 Applicator

Use an air purge foam spray gun.

1.12.2 Equipment Calibration

Fully calibrate the foam metering equipment to monitor each liquid component to within 2 percent of the SPF manufacturer's required metering ratio. Calibrate spray equipment each day at the start of operations, after each restart if spraying operations have been terminated for more than one hour, whenever there is a change in fan pattern or pressure, whenever slow curing areas are noticed, whenever a change is made in hose length or working height, and after changeover between materials. Calibration consists of demonstrating that the equipment is adjusted to deliver components in proper mix and proportion. Conduct calibration tests on cardboard or plywood on a wall adjacent to the area to be sprayed.

1.12.3 Metering Equipment Requirements

Use foam metering equipment capable of developing and maintaining the SPF manufacturer's required liquid component pressures and temperatures. Foam metering equipment must have gages for visual monitoring. Equipment must provide temperature control of foam components to within the temperature ranges recommended by the foam manufacturer's printed instructions.

1.12.4 Moisture Protection

Protect surfaces of supply containers and tanks used to feed foam metering equipment from moisture.

1.12.5 Compressed Air

Supply compressed air that is in contact with SPF during mixing or atomization through moisture traps that are continuously bled.

1.12.6 Dispense Excess Materials

Do not deposit materials used for cleaning of equipment or materials dispensed for calibration purposes and establishment of spray gun pattern onto the ground. Dispense such materials into scrap containers or onto plastic film, or cardboard, and dispose of in accordance with safety requirements and jobsite regulations.

PART 2 PRODUCTS

2.1 SPRAY FOAM AIR BARRIER

2.1.1 General

Provide a closed cell, sprayed in place, SPF that forms a continuous air/vapor/thermal barrier at the building enclosure. Provide in accordance with ASTM C1029, with the requirements of UFC 3-600-01, ICC IBC Chapter 26, ICC-ES AC377, and NFPA 285. In the event of a conflict, the most stringent requirement applies. Provide all system components necessary for a complete, code compliant installation, whether indicated or not, including material support components, expansion and contraction

joints, ignition barrier coatings, thermal barrier materials, and accessories.

2.1.2 Physical Properties

Provide a closed cell product with the following characteristics:

a. Density (ASTM D1622): 2.0 lb per cf, nominal

b. Thermal Resistance (ASTM C518)

(1) Initial R-value per inch thickness: 7 sf·degrees F h per Btu

(2) Aged R-value per inch thickness (180 days at 76 degrees F): 6.6 sf·degrees F·h per Btu

c. Air Permeance (ASTM E2178): Less than 0.004 CFM per sf at 1.57 psf.

d. Air Leakage (ASTM E2357, ASTM E283): less than 0.004 CFM per sf at 1.57 psf at one inch.

e. Compressive Strength (ASTM D1621): Minimum 28.3 psi

f. Tensile Strength (ASTM D1623)

(1) Medium density: 15 psi

g. Water Vapor Permeance (ASTM E96/E96M, water method): less than 1.2 US Perms at one inch thickness

h. Vapor Retarder (ICC IBC, ICC IECC) Class III

i. Surface Burning Characteristics (ASTM E84) 3 inch thickness:

(1) Flame Spread (FS) Index Rating less than 25.

(2) Smoke Developed (SD) Index Rating less than 150. SPF with an SD rating greater than 150 but less than 450 may be used when fully encapsulated. Approval of SPF product is contingent upon approval of encapsulation products and assemblies..

j. Closed Cell Content (ASTM D6226): 90 percent

k. Dimensional Stability (Humid Aging) (ASTM D2126): 15 percent at 28 days at 158 degrees F with 97 percent relative humidity.

l. Water Absorption (ASTM D2842): Maximum 1.0 per volume

m. Fungi Resistance (ASTM C1338): Pass, with no growth

2.1.3 Expansion and Contraction

Provide an assembly that allows for relative movement due to temperature, moisture, and air pressure changes. Provide expansion and contraction measures as required by the manufacturer's written recommendations.

2.1.4 Fire-ratings, Flame Spread and Smoke Developed Index Ratings

Where fire-rated materials are indicated, provide products with the appropriate markings of a qualified testing agency. Submit fire-rating test reports. Submit flame spread (FS) and smoke developed (SD) index data. Where FS and SD values of foam products do not meet requirements, provide corresponding ignition and thermal barrier products or assemblies and verify complete encapsulation of the spray foam air barrier through product data or on shop drawings. Submit for approval in accordance with Section 01 33 00 SUBMITTAL PROCEDURES.

2.1.5 Prohibited Materials

Products that contain hexabromocyclododecane (HBCD) flame retardants are prohibited. Products that contain hydrochlorofluorocarbons (HCFCs), chlorofluorocarbons (CFCs), or other high ozone depleting blowing agents, are prohibited. For a list of acceptable substitute foam blowing agents see https://www.epa.gov/snap/foam-blowing-agents. Provide validation of indoor air quality for spray foam air barrier that no prohibited materials are used.

2.1.6 Thermal and Ignition Barrier

Provide a thermal barrier and ignition barrier in locations where SPF is exposed to the interior of the building, including attics and plenum spaces. Provide thermal and ignition barriers in accordance with ICC IBC Chapter 26 "Plastics," with ICC-ES AC377, ASTM E736, and NFPA 275. Choose one or more of the following methods of separation:

a. Building interior, other than fire-rated enclosures: Separate the SPF from the occupied interior of a building by an intumescent thermal barrier coating or thermal barrier board identical to a third party tested thermal barrier to limit the average temperature rise of the surface of the SPF to not more than 250 degrees F after 15 minutes of fire exposure (using the standard time-temperature curve of ASTM E119). Provide in accordance with NFPA 275.

b. Building interior, fire-rated enclosures: At walls, ceilings and floors that are required to be fire-rated, separate the SPF from the occupied interior of a building with an ignition barrier consisting of 5/8 inch, Type X, fire-rated GWB in the number of layers corresponding to required ratings. Include all accessories as necessary for complete fire-rated assemblies.

c. Unoccupied attics, crawl spaces: Where fire-rated enclosures are not required, and where entry is made only for service of utilities, separate the SPF from the attic or crawl space with a continuous ignition barrier in accordance with ICC IBC Chapter 26 requirements, and as approved by the Contracting Officer's Representative. Provide one of the following:

(1) 1-1/2 inch thick mineral fiber insulation

(2) 1-1/2 inch thick cellulose insulation

2.2 PRIMERS, ADHESIVES, AND MASTICS

Provide primers, adhesives, mastics and other accessory materials as recommended by spray foam manufacturer's printed literature.

2.3 JOINT SEALANTS

As specified in Section 07 92 00 JOINT SEALANTS. Verify compatibility with other system products.

PART 3 EXECUTION

3.1 EXAMINATION

Before installing the spray foam air barrier and with the installer present, examine substrates, areas, and conditions under which SPF will be applied, for compliance with requirements. Ensure that surfaces are sound, dry, even, and free of oil, grease, dirt, excess mortar or other contaminants. Ensure that concrete surfaces are cured and dry, smooth without large voids, spalled areas or sharp protrusions. Correct defects that adversely affect the spray foam application or performance. Verify that work by other trades is in place and complete prior to application of spray foam.

3.2 PREPARATION

3.2.1 Substrate Preparation

Clean, prepare, and treat substrate according to manufacturer's written instructions. Provide clean, dust-free, and dry substrate for spray foam application.

a. Prepare surfaces by brushing, scrubbing, scraping, or grinding to remove loose mortar, dust, oil, grease, oxidation, mill scale and other contaminants which will affect adhesion of the SPF.

b. Wipe down metal surfaces to remove release agents or other non-compatible coatings, using clean sponges or rags soaked in a solvent compatible with the SPF.

3.2.2 Protection

Protect adjacent areas and surfaces from spray applied materials in accordance with the following:

a. Mask and cover adjacent areas to protect from over spray.

b. Ensure required foam stops and back up materials are in place to achieve a complete seal.

c. Seal off ventilation equipment. Install temporary ducting and fans to provide required exhaust of spray fumes. Provide make-up air as required.

d. Erect barriers, isolate area, and post warning signs to notify non-protected personnel of the requirement to avoid the spray area.

3.2.3 Blocking Around Heat Producing Devices

Install non-combustible blocking around heat producing devices to provide the following clearances:

a. Recessed light fixtures, including wiring compartments, ballasts, and

other heat producing devices, unless certified for installation surrounded by insulation: Minimum of 3 inches from outside face of fixtures and devices and in accordance with NFPA 70 and, if insulation is to be placed above fixture or device, 24 inches above fixture.

b. Gas Fired Appliances: Clearances in accordance with NFPA 54.

c. Oil Fired Appliances: Clearances in accordance with NFPA 31. Blocking is not required if chimneys or flues are certified by the manufacturer for use in contact with insulating materials.

3.2.4 Fire and Explosion Hazards

Prohibit open flames, sparks, welding, and smoking in the application area. Provide and maintain fire extinguishers of appropriate type, size and distance, as required by NFPA, in the application area. Mix batches in small enough quantities to avoid spontaneous combustion from exothermic heat build-up of SPF components during curing.

3.2.5 Warning Signs

Post warning signs at ground level adjacent to the work area and a minimum of 150 feet from the application area stating the area is off limits to unauthorized persons and warning of potential hazards. Place clearly visible and legible warning sign at entrance to primary road leading to the project facility warning of presence of flammable materials, irritating fumes, and potential of overspray damage.

3.2.6 Prime Substrate

Provide as recommended by the manufacturer for each substrate to be primed. Use primers at full strength. Do not dilute primers unless required and as recommended in writing by the manufacturer. Do not use cleaning solvents for thinning primers or other materials. Ensure that diluted primer(s) meet VOC requirements.

3.3 INSTALLATION

3.3.1 Sequencing and Coordination

Sequence the work so as to prevent access to the work area by other trades during foam application and curing. Limit access of non-essential workers during application. Notify the Contracting Officer 24 hours in advance of spraying operations. Sequence spray foam work with other trades to permit continuous self-flashing of the spray foam air barrier. Ensure expansion and control joints are provided as detailed on the manufacturer's shop drawings to accommodate the expansion of each layer of the air/vapor/thermal envelope. Provide temporary fire protection of uncured foam, and isolate the work area, until foam application is isolated with a permanent thermal or ignition barrier.

3.3.2 Installation of Spray Foam Air Barrier

Install materials in accordance with paragraph SAFETY PROVISIONS, in accordance with manufacturer's recommendations, ULC S705.2 Installation Standard, and in accordance with the following:

a. Use spray equipment that complies with foam manufacturer's recommendations for the specific type of application, and as specified

herein. Record equipment settings on the Daily Work Record. Each proportioned unit can supply only one spray gun.

b. Apply only when surfaces and environmental conditions are within limits prescribed by the material manufacturer.

c. Continuously connect the spray foam air barrier between walls, roof, floor, and below grade assemblies to form a continuous integrated air barrier system around the entire building enclosure. Extend the spray foam air barrier into rough openings such as doors, windows, louvers, and other exterior penetrations. Use self-adhering air barrier transition strips if necessary to achieve full extension and continuity of the barrier at these locations. Seal edges of barrier at junctures with rough openings.

d. Install within manufacturer's tolerances, but not more than minus 1/4 inch or plus 1/2 inch.

e. Sequence work so as to completely seal all penetrations resulting from pipes, vents, wires, conduit, electrical fixtures, structural members, or other construction. If penetrations through the spray foam air barrier are made after the initial SPF application, reapply in accordance with manufacturer's written instructions for such remedial work.

f. Do not install SPF within 3 inches of heat emitting devices such as light fixtures and chimneys.

g. Finished surface of SPF must be free of voids and embedded foreign objects.

h. Remove masking materials and over spray from adjacent areas immediately after foam surface has hardened. Ensure cleaning methods do not damage work performed by other sections.

i. Trim, as required, any excess thickness that would interfere with the application of cladding and covering system by other trades.

j. Clean and restore surfaces soiled or damaged by work of other trades. Before cleaning and restoring damaged work, consult with other trades for appropriate and approved methods for cleaning and restoration to prevent further damage.

k. Complete connections to other components and repair any gaps, holes or other damage using material approved by the manufacturer.

l. Provide expansion joints in the SPF application aligned with expansion joints in the building enclosure, where substrate materials change, and in accordance with manufacturer's recommendations.

m. Provide a continuous fire watch in accordance with paragraph SAFETY PROVISIONS.

3.4 FIELD QUALITY CONTROL

3.4.1 General Site Inspections

Provide site inspections in accordance with ABAA protocol to verify conformance with the manufacturer's instructions~~,~~ and the ABAA QAP Quality

Assurance Program (https://www.airbarrier.org/qap/)~~, Section 07 27 10.00 10 BUILDING AIR BARRIER SYSTEM, and this section~~.

a. Conduct inspections at 5, 50, and 95 percent of completion of this scope of work. Forward written inspection reports to the Contracting Officer within 5 working days of the inspection being performed.

b. If inspections reveal any defects, promptly remove and replace defective work at no additional expense to the Government.

3.4.2 Manufacturer Site Inspections

Manufacturer's technical representative must visit the site during the installation process to ensure the SPF and accessories are being applied in compliance with requirements. At a minimum, manufacturer's technical representative must be present at work startup and perform field inspection of the first day's completed application and at substantial completion, prior to demobilization. After each inspection, submit an inspection report signed by the manufacturer's technical representative, to the Contracting Officer within five working days. The inspection report must note overall quality of work, deficiencies, and recommended corrective actions in detail. Notify the Contracting Officer a minimum of two working days prior to site visits by manufacturer's technical representative.

3.4.3 Contractor's Site Inspections

Establish and maintain an inspection procedure to ensure compliance of the foam installation with contract requirements. Conduct inspections and testing at 5, 50, and 95 percent completion of application. Forward written inspection reports to the Contracting Officer within five working days of the inspection and test being performed. Work not in compliance must be promptly removed and replaced or corrected, in an approved manner, at no additional cost to the Government. Quality control must include, but is not limited to, the following:

a. Observation of environmental conditions; number and skill level of insulation workers.

b. Verification of certification, listing, or label.

c. Verification of proper storage and handling of materials before, during, and after installation.

d. Inspection of SPF, support structure, primer, expansion joints, ignition barrier, thermal barrier, vapor retarder, and accessories.

3.4.4 Field Peel Adhesion Test

Conduct in accordance with test protocol indicated in Part 1 paragraph FIELD PEEL ADHENSION TEST.

3.5 CORRECTION OF DEFICIENCIES

Upon completion of inspection, or sample taking, repair damaged construction, restore substrates and finishes, and protect repaired construction. Deficiencies found during inspection must be corrected following notification.

3.6 CLEANUP OF SPILLS

Conduct cleanup of uncured product spillage in accordance with paragraph SAFETY PROVISIONS and the manufacturer's written safe handling instructions. In the event of a conflict, the most stringent requirement governs.

3.7 PROTECTION AND CLEANING

3.7.1 Protection of Installed Work

Protect SPF installation from damage during application and remainder of construction period in accordance with manufacturer's written instructions. Repair damaged areas to new condition.

3.7.2 Cleaning of Adjacent Surfaces

Clean overspray from adjacent construction using cleaning agents and procedures as recommended in writing by the manufacturer of each type of affected construction and as acceptable to same.

-- End of Section --

SECTION 13 21 48

ACOUSTIC ISOLATION CONSTRUCTION
04/06

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D1056	(2014) Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber

1.2 RELATED REQUIREMENTS

03 30 00~~.00 10~~ CAST-IN-PLACE CONCRETE

04 20 00 MASONRY

~~08 34 73 SOUND CONTROL DOOR ASSEMBLIES~~

21 13 13.00 10 WET PIPE SPRINKLER SYSTEM, FIRE PROTECTION

~~23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS~~

23 00 00 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEMS

26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS

26 20 00 INTERIOR DISTRIBUTION SYSTEM

1.3 PERFORMANCE REQUIREMENTS

1.3.1 Acoustic Isolation

Acoustic isolation construction shall be provided where indicated in the drawings.

1.3.2 Specific Construction

Specific construction sequencing due to isolation details and field observation requirements will be necessary. Sequencing shall be reviewed and coordinated by the field supervisors. The construction inspection sequence is outlined in the field quality control section of this specification.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals with an "S"

are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submittals with an "AE" are for submittal to the Designer of Record. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

~~Conform to submittal requirements of Section 11 70 00 GENERAL REQUIREMENTS FOR MEDICAL AND DENTAL EQUIPMENT.~~

SD-03 Product Data

Angle Bracketss

Bond Breaker Material

Masonry Wall Sway Braces

Perimeter Isolation Board

Perimeter Caulking Compound

Ceiling Isolation Hangers

Ductwork and Ceiling Services Hanger

Outlet and Junction Box Backing Material

Sound Barrier Lagging Material

Neoprene Sponge MaterialSD-04 Samples

~~SD-06 Test Reports~~

~~Noise reduction test~~

~~Sound absorption test~~

~~Interior noise level test~~

~~Submit test reports indicating compliance with the performances listed in paragraph entitled "Performance Requirements."~~

SD-07 Certificates

1.5 WARRANTY

Upon completion of the work of this section, and as a condition of its acceptance, deliver to the construction manager two copies of the manufacturer's standard written two-year warranty.

PART 2 PRODUCTS

2.1 BASIS OF DESIGN PRODUCTS

Acoustic isolation construction basis of design components are indicated within this specification. Provide basis of design product or approved equal where these components are indicated.

2.2 ANGLE BRACKETS

Angle iron sections with provision for bolting to the structure and a minimum thickness of 3/8 inch sponge cemented to the vertical leg. Size as indicated in the drawings. Basis of design to be Mason Industries AB-716.

2.3 BOND BREAKER MATERIAL

Provide two (2) layers of 6 mil polyethylene sheeting.

2.4 MASONRY WALL SWAY BRACES

Sway braces designed to be fastened to non-isolated construction wall and attached to isolated masonry wall construction with a hooked rod embedded in horizontal grout joints. Spacing as indicated in the drawings.

Sway braces to incorporate minimum 1 inch thick fiberglass or elastomer isolation element with a nominal natural frequency of plus or minus 3Hz. Basis of design to be Mason Industries DNSB. Spacing as indicated in the drawings.

Basis of design to be Mason Industries DNSB.

2.5 PERIMETER ISOLATION BOARD

PVC Foam isolation board.

Basis of design to be Mason Industries P7.

2.6 PERIMETER CAULKING COMPOUND

Non-hardening, drying or bleeding, troweling or pouring grade caulking compound shall be Mason Industries Type CC 75.

2.7 CEILING ISOLATION HANGERS

Spring and neoprene isolator elements within a steel retainer box.

Provide sufficient clearance between retainer box and spring hanger to permit minimum 15-degree rod misalignment in any direction; total 30 degrees.

Provide molded neoprene cup/bushing which holds spring and provides a bushing which lines the spring rod penetration within the retainer box.

Minimum spring diameter of 0.8 of the loaded operating height.

Reserve spring deflection (from loaded to solid height) of 50 percent of the rated deflection.

Neoprene element to be a neoprene-in-shear design which provides minimum 0.35 inch deflection at rated load.

Minimum static deflection at installed and operating conditions is to be 1.35 inches.

Basis of design to be Mason Industries "30N".

2.8 DUCTWORK AND CEILING SERVICES HANGER

Spring and elastomer hanger rod isolator.

Spring to provide a nominal 1 inch deflection.

Elastomer element to provide a nominal 0.25 inch deflection.

Steel retainer box encasing neoprene mounting.

Provide sufficient clearance between retainer box and spring hanger to permit minimum 15-degree rod misalignment in any direction; total 30 degrees

Basis of design to be Mason Industries "30N"

2.9 OUTLET AND JUNCTION BOX BACKING MATERIAL

Heavy density 1.48 grams/cm^3 putty material.

Basis of design to be Hilti North America, type CP 617 Firestop Putty Pad.

2.10 SOUND BARRIER LAGGING MATERIAL

Composite insulation and sound barrier lagging material.

Lagging material to be 1 pound per square foot.

Batt insulation to be nominal 1 inch thick.

Lagging material to comply with all fire and smoke ratings in the installed condition.

Basis of design to be SoundSeal B-10 LAG/QFA-30.

2.11 NEOPRENE SPONGE MATERIAL

Closed Cell Neoprene Sponge

ASTM D1056 78

Type II = Closed Cell

Grade A = 30 Deg F to 150 Deg F Oil Resistant and Self Extinguishing

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 General

All penetrations through isolated construction shall be acoustically sealed with resilient sealant material.

Coordinate and review base building construction for appropriate installation environment.

Cement perimeter isolation board around all walls, columns, curbs, etc.

3.1.2 Isolated Suspended Ceiling Installation

Hangers for services below resiliently suspended ceilings shall be coordinated and installed prior to construction of the resilient ceiling structure. Hangers for all services shall be resilient.

All electrical and low voltage services and and conduit shall be flexible between independent wall, and at penetrations through sound barrier ceilings.

3.1.3 Sound Barrier Lagging

All supply and return ductwork above sound barrier ceilings is to be acoustically lagged or wrapped.

3.1.4 Flexible Duct Connections

Flexible duct connections shall be provided within all ductwork between independent isolated walls of the spaces outlined above. Flexible connector material specified elsewhere in design documents.

3.1.5 Outlet & Junction Box Backing Material

All in-wall outlet and junction boxes within the isolated spaces.

3.2 FIELD QUALITY CONTROL

3.2.1 Inspection

Examine each item for visual defects, and correct all defects to conform to the specifications.

3.2.2 Inspection Sequence

The field supervisor shall inform the owner and construction manager a minimum of 4 days prior to completion of the following installation inspection stages. At the completion of each stage no further construction shall occur until field supervisor has received approval from the owner and construction manager of the completed work.

After the installation of masonry wall angle brackets and prior to finishing top course of masonry wall.

After the installation of ceiling hangers, ceiling framing, above ceiling systems, and hangers and supports for below ceiling systems.

After the installation of ceiling insulation and drywall.

-- End of Section --

SECTION 14 24 23

HYDRAULIC PASSENGER ELEVATORS
05/16

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020) Structural Welding Code - Steel

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME A17.1/CSA B44	(2016) Safety Code for Elevators and Escalators
ASME A17.2	(2017) Guide for Inspection of Elevators, Escalators, and Moving Walks Includes Inspection Procedures for Electric Traction and Winding Drum Elevators, Hydraulic Elevators, and Escalators and Moving Walks
ASME A17.5/CSA B44.1	(2019) Elevator And Escalator Electrical Equipment
ASME A18.1	(2020) Safety Standard For Platform Lifts And Stairway Chairlifts
ASME B16.11	(2016) Forged Fittings, Socket-Welding and Threaded
ASME B16.9	(2018) Factory-Made Wrought Buttwelding Fittings

ASTM INTERNATIONAL (ASTM)

ASTM A106/A106M	(2019a) Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A53/A53M	(2020) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41	(1991; R 1995) Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits

INTERNATIONAL CODE COUNCIL (ICC)

ICC IBC	(2018) International Building Code

NATIONAL ELEVATOR INDUSTRY, INC. (NEII)

NEII-1	(2000; R thru 2017) Building Transportation Standards and Guidelines, including the Performance Standards Matrix for New Elevator Installation

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 101	(2018; TIA 18-1; TIA 18-2; TIA 18-3) Life Safety Code
NFPA 70	(2020; ERTA 20-1 2020; ERTA 20-2 2020; TIA 20-1; TIA 20-2; TIA 20-3; TIA 20-4) National Electrical Code
NFPA 70E	(2018; TIA 18-1; TIA 18-2) Standard for Electrical Safety in the Workplace
NFPA 72	(2019; TIA 19-1; ERTA 1 2019) National Fire Alarm and Signaling Code

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-560-01	(2017, with Change 2, 2019) Operations and Maintenance: Electrical Safety

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

36 CFR 1191	Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance with Section 01 33 29 SUSTAINABILITY REPORTING. Submittals with an "AE" are for submittal to the Designer of Record. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Elevator System; G, RO

Elevator Components; G, RO

Elevator Machine; G, RO

Elevator Controller; G, RO

Wiring Diagrams; G, RO

Interior Cab Finishes Detail Drawings; G, AE

Commercial Wheelchair Lift System & Components; G, RO

SD-04 Samples

SST Finish Samples for Pre-Engineered Interior Finish System (4x4); G, AE

SD-03 Product Data

Elevator and Accessories; G, RO

Elevator Components; G, RO

Data Sheets; G, RO

Elevator Microprocessor Controller; G, RO

Commercial Wheelchair Lift; G, RO

SD-05 Design Data

Emergency Power, Systems, and Operations

Heat Loads

Reaction Loads

SD-07 Certificates

Elevator Parts and Components Price Lists; G, RO

Warranty

Endorsement Letter

Welders' Qualifications

Elevator Controller Certification; G, RO

SD-10 Operation and Maintenance Data

Elevator, Data Package 4; G, RO

Maintenance Control Program (MCP); G, RO

Software and Documentation; G, RO

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA and 01 78 24.05 20 FACILITY OPERATION AND MAINTENANCE SUPPORT INFORMATION.

Commercial Wheelchair Lift, Data Package 4; G, RO

1.2.1 Shop Drawing Requirements

~~Provide assembly and arrangement of elevators, accessories, and elevator components~~Provide assembly and arrangement of elevators, accessories, elevator components, and Commercial Wheelchair Lift. Show location of elevator machine in elevator machine room (MR) or machinery space (MS). Show location of elevator controller in elevator machine room or elevator control room (CR). Provide details for materials and equipment, including but not limited to operating and signal fixtures, doors, door and car frames, car enclosure, controllers, motors, guide rails and brackets, layout of hoistway in plan and elevation, the Commercial Wheelchair Lift, and other layout information and clearance dimensions and other layout information and clearance dimensions.

Provide assembly and arrangement of commercial wheelchair lifts, accessories, and commercial wheelchair lift system & components. Show location of all remote components in the surrounding rooms. Provide details for materials and equipment, including but not limited to operating and signal fixtures, doors, door and lift frames, lift enclosure, controllers, motors, guide rails and brackets, layout of lift in plan and elevation, and other layout information and clearance dimensions.

Provide interior cab finishes detail drawings in elevation and plan to include but not be limited to: ceiling layout, wall panel seaming/reveals, handrails, bumper rails and wall base.

1.2.2 Delivery, Storage and Handling of Interior Finishes

Deliver materials to install on site in manufacturer's original packaging. Store in dry, secure location, protected against direct sunlight and excessive heat. Protect finished surfaces with strippable film.

1.2.3 Warranty

Provide manufacturer standard warranty for pre-engineered interior finish system. Terms: One year against defects in material and workmanship.

1.2.4 Product Data Requirements

Provide manufacturers' product data for all elevator and commercial wheelchair lift components, including but not limited to the following: elevator controller, hydraulic pump unit, hydraulic pump and motor, hydraulic cylinder, hydraulic piping and fittings, car and hall fixture buttons and switches, cab and machine room or control room communication devices, door operator, door protection system, car roller guides, and buffers. For data sheets, provide document identification number or bulletin number, published or copyrighted prior to the date of contract bid opening. Provide controller manufacturer's published procedures for performance of each and all testing required by ASME A17.1/CSA B44.

1.2.5 Design Data

1.2.5.1 Reaction Loads

Provide calculations by registered professional engineer for reaction loads imposed on building by elevator system. Demonstrate calculations complying with ASME A17.1/CSA B44

1.2.5.2 Heat Loads

Provide calculations from elevator manufacturer, or by registered professional engineer, for total anticipated heat loads generated by all of the elevator equipment.

1.2.6 Welders' Requirements

Comply with AWS D1.1/D1.1M, Section 5. Include certified copies of field welders' qualifications. List welders' names with corresponding code marks to identify each welder's welding work

1.2.7 Maintenance Control Program (MCP)

For each elevator, prepare and provide a written Maintenance Control Program (MCP) that complies with ASME A17.1/CSA B44 Section 8.6, including written documentation that details the test procedures for each and every test that is required to be performed by ASME A17.1/CSA B44. Assemble all MCP documentation, and supporting technical attachments, in a single MCP package and provide in both electronic and hard copy. Assemble entire hard copy MCP in 3-ring binders. For each elevator provided, the MCP must include only documentation and instruction that apply to the elevator specified.

For each elevator, provide an additional, separate binder that includes all maintenance, repair, replacement, call back, and other records required by ASME A17.1/CSA B44. The records binder must be kept in the elevator mechanical room, maintained by elevator maintenance and service personnel, and be available at all times to authorized personnel.

Provide detailed information regarding emergency service procedures and elevator installation company personnel contact information. Provide a listing of all tools to be provided to the Contracting Officer as components of the elevator system.

1.2.8 Emergency Power, Systems, and Operations

Include full description of emergency power, systems, and operations.

1.3 QUALITY ASSURANCE

1.3.1 Qualification

Provide a designed and engineered elevator system by an elevator contractor regularly engaged in the installation of elevator systems. Provide elevator components manufactured by companies regularly engaged in the manufacture of elevator components. Utilize only licensed and certified elevator personnel for the installation, adjusting, testing, and servicing of the elevators.

1.3.1.1 Elevator Contractor's Elevator Technicians

For elevator installations in the United States, including United States territories, perform all elevator related work under the direct guidance of a state certified elevator technician with a minimum of three years of experience in the installation of elevator systems of the type and complexity specified in the contract documents. Provide an endorsement letter from the elevator manufacturer, certifying that the elevator specialist is qualified. All elevator technicians must carry a current

certification issued by one of the following organizations:

a. National Association of Elevator Contractors (NAEC)

b. National Elevator Industry Education Program (NEIEP)

1.3.2 Manufacturers' Technical Support

Provide elevator components from manufacturers that provide factory training and online and live telephone elevator technical support to any elevator installation, service, and maintenance contractor. Provide elevator components from manufacturers that guarantee accessibility to all replacement and repair parts and components to any elevator installation, service, and maintenance contractor. Use only elevator component manufacturers that provide current published price lists for all elevator parts and components.

1.3.3 Operation and Maintenance Data

Assemble all shop drawing and product data material into O&M Data Packages in accordance with Article SUBMITTALS. Provide two complete O&M Data Packages in hard copy and two complete electronic O&M data packages on separate CDs, in PDF format. Provide all O&M Data Packages to Contracting Officer. Include controller diagnostic documentation and software as required under Article CONTROL EQUIPMENT.

1.3.4 Wiring Diagrams

Provide complete wiring diagrams and sequence of operations, which show electrical connections and functions of elevator systems. Provide one set (11 inch by 17 inch minimum size) of wiring diagrams, with individual sheets laminated in plastic and assembled in binder, to be stored in the machine room or control room cabinet. Provide one additional hard copy set and two complete electronic sets on separate CDs, in PDF format. Provide all wiring diagram sets to the Contracting Officer. Coded diagrams are not acceptable unless fully identified.

1.3.5 Machine Room/Control Room Cabinet

For storage of O&M Data Packages and Wiring Diagrams, provide locking metal cabinet with a minimum size of 20 inch W by 12 inch D by 30 inch H. Cabinet must be sized large enough to accommodate all O&M Data and hardware required in paragraphs OPERATION AND MAINTENANCE DATA and WIRING DIAGRAMS. Secure cabinet to machine room or control room wall.

1.4 NEW INSTALLATION SERVICE

Provide elevator warranty service in accordance with the manufacturer's maintenance plan, warranty requirements and applicable safety codes, for a period of 12 months after the date of acceptance by Contracting Officer. Perform this work during regular working hours. Provide supplies and parts to keep elevator system in operation. Perform service only by factory trained personnel. Provide Monthly services to include repairs, adjustments, greasing, oiling, and cleaning. Provide service log in elevator machine room or control room and update Monthly, throughout the one-year warranty period.

Provide 24-hour emergency service, with one hour on-site response time, during this period without additional cost to the Government.

1.4.1 Periodic Elevator Certification Inspection and Testing

Provide elevator mechanic to support QEI Certified Elevator Inspector in the periodic six-month and the annual Category 1 elevator certification inspection and testing. Perform Category 1 inspection and testing no greater than 30 days prior to the end of the warranty period. Perform all elevator certification testing in the presence of QEI Certified Elevator Inspector.

In conjunction with the testing noted above, test systems for Emergency Power Operation, Earthquake Emergency Operation, and Hospital Emergency Commandeering Service Operation, as applicable. Schedule so that testing does not interfere with building operations.

1.5 FIRE PROTECTION SYSTEM

Coordinate interface between building fire protection system and elevator controls.

Additional fire protection requirements are located in: Section 28 31 76 INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM; Section 21 13 13.00 10 WET PIPE SPRINKLER SYSTEM, FIRE PROTECTION; and Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

1.5.1 Fire Alarm Initiating Devices

Fire alarm initiating devices are specified in 28 31 76 INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM, including conduit and wiring from each detector to fire protection addressable modules in elevator machine room or control room.

1.5.2 Fire Sprinklers

Provide fire sprinklers in accordance with all applicable safety codes and with Section 21 13 13.00 10 WET PIPE SPRINKLER SYSTEM, FIRE PROTECTION. Provide shutoff valve, check valve, and non-adjustable, zero time-delay flow switch, in each sprinkler line immediately outside of each machine room, control room, and hoistway, as applicable. Provide inspectors' test valve for periodic testing of flow switch and shunt trip disconnect.

Pipe sprinkler piping serving these spaces in a series manner with no laterals. Locate inspectors' test connection at the end of pipe runs such that operation of the test connection will purge air from system piping.

1.5.3 Shunt Trip Disconnect

Provide flow switches specified in paragraph FIRE SPRINKLERS to comply with ASME A17.1/CSA B44 and NFPA 72 for shunt trip of the main line power supply. For each elevator, provide control wiring connecting the flow switch to a shunt trip equipped circuit breaker located in the elevator machine room or control room. Upon flow of water, flow switch will instantaneously cause opening of the shunt-trip circuit breaker and remove power from the elevator. Flow switch must also send a signal to fire alarm control panel to indicate water flow condition.

PART 2 PRODUCTS

2.1 ELEVATOR DESCRIPTION

Provide elevator system that complies with ASME A17.1/CSA B44 in its entirety, ASME A17.2 in its entirety, and additional requirements specified herein. Provide elevator system that meets or exceeds the NEII-1 Ride Quality Performance Standards Matrix (RQPSM). Comply with the RQPSM "Intermediate Performance" criteria.

Provide and install elevators in accordance with 36 CFR 1191 - ABAAS, ICC IBC, IEEE C62.41, NFPA 70 and NFPA 101 requirements.

2.1.1 Elevator Design Parameters

2.1.1.1 Elevator No. 1 - Emergency Medical Service Accessibility (EMSA)

Provide elevator(s) with minimum size and arrangement to accommodate an ambulance stretcher 24-inch by 84-inch with not less than 5-inch radius corners, in the open, horizontal position.

a. Type: In-Ground Direct Plunger

b. Rated load: 3500 lb.

c. Rated Speed: 150 fpm

d. Car Door Type: Single-speed side slide.

e. Car Door Opening Width: 3 ft.-6 in. minimum.

2.1.2 Cab Enclosure and Hoistway Entrance Assemblies

2.1.2.1 Cab Enclosures and Door Finishes

Provide all interior finishes as indicated on Finish Location Plan Drawings and as specified in this section.

a. Floor: Rubber sheet flooring as indicated on Finish Plans shall be flush with cab sill.

b. Interior Rear and Side Wall Panels:Pre-engineered elevator interior system including stainless steel clad panels over fire-rated MDF backer with .020-inch aluminum sealer sheet and z-clip mounting system. Panel configuration to match layout identified in Drawings. Stainless steel finish shall be textured to be "smudge-proof" with SST reveals in finish identified on Drawings. All fasteners shall be concealed. Interior face of doors to match wall panels. Provide 4-inch high SST wall base in finish to match wall panels.

c. Provide SST handrails on rear and side walls at 34 inches above finished floor on center. Handrail to stop short of perpendicular walls by 6 inches. Style of rail shall be 1.25 inches in diameter with radius bend at ends in SST stippled finish. SST Finish Samples for Pre-Engineered Interior Finish System (4x4).

d. Ceiling System: Canopy mounted six equal SST panels with painted reveals mounted on fire-rated particleboard substrate with aluminum backer and integral lighting system. Ceiling to have continuous 2-inch

clearance at perimeter of suspended ceiling for ventilation. Paint exposed surfaces above wall panels with fire-rated intumescent paint. Provide removable exit hatch per ASME A17.1/CSA B44for emergency egress. (Location to be verified in field.) Stainless steel finish as indicated on Ddrawings.

e. Lighting: Provide six recessed LED downlights centered in panels with continuous LED perimeter lighting in pre-installed aluminum housing. Provide emergency lighting system with additional system with additional power supply and a battery with automatic charger.

f. Hoistway Doors and Frame Finishes - Provide finishes on exterior of hoistway as follows:

1. Frame: Prefinished steel to match door finish.

2. Exterior Face of Door Stainless steel to match interior face.

3. Protect elevator finishes, fixtures and equipment from damage caused by work per this section. Install in accordance with elevator interior system instructions. Do not make structural changes to elevator car or install work in a manner that interferes with the safe operation of the elevator.

2.2 ELEVATOR OPERATION

ASME A17.1/CSA B44, Introduction, Section 3, Definitions.

2.2.1 Selective Collective Automatic Operation

Provide Selective Collective Automatic Operation.

2.3 SPECIAL OPERATION AND CONTROL

Provide the following special operations and control systems.

2.3.1 Keys for Elevator Key Switches

Provide a minimum of twelve keys per unique cylinder used on all key switches for a single elevator. If there is more than one elevator, additional keys will not be required unless there are additional unique lock cylinders. Provide keys with brass or fiberglass tags marked "PROPERTY OF THE U.S. GOVERNMENT" on one side with function of key or approved code number on the other side.

2.3.2 Firefighters' Emergency Operation (FEO)

Provide FEO equipment and signaling devices. The designated level for the FEO Phase I key operated switch is the ground floor. In the FEO Phase I fixture, provide FEO Operating Instructions.

2.3.2.1 Firefighters' Emergency Operation (FEO) Key Box

Provide flush mounted, locking, FEO Key Box of a minimum size of 5 inch W by 9 inch H by 1.5 inch D. Install at a height of 6 feet above floor level and directly above the FEO Phase I key switch. Provide box equipped with lock that uses the FEO K1 key.

2.3.3 Hoistway Access Operation

Provide hoistway access operation with switches at top and bottom terminal landings. Locate switch 6 feet above floor level, within 12 inches of elevator hoistway entrance frame or with the ferrule exposed when located in the elevator entrance frame.

2.3.4 In-Car Inspection Operation

Provide In-Car Inspection Operation.

2.3.5 Independent Service

Provide exposed key-operated switch in car operating panel to enable independent service and simultaneously disable in-car signals and landing-call responses. Provide indicator lights that automatically illuminate during independent service. For duplex or group operation, if one car is removed from group another car will respond to its hall calls.

2.3.6 Elevator Auxiliary Power Operating System

Provide elevator auxiliary power operating system for Elevator No. 1.

2.4 ELEVATOR DRIVE SYSTEM

Provide hydraulic elevator drive system, including pump unit, piping, cylinder/plunger assembly, and associated equipment, which will operate at a maximum working pressure of 500 psi or less. Provide complete elevator system that meets or exceeds the NEII-1 Ride Quality Standard, including elevator ride quality and noise levels in car and in elevator machine room and machinery space.

2.4.1 Hydraulic Pump Unit

Provide self-contained pump unit, including oil-hydraulic elevator pump, electric motor, suction-line oil strainer, and structural steel outer base with tank supports and isolation pads. Provide oil tank capacity for full plunger displacement plus at least 10 gallons. Provide means to maintain oil temperature between 100 and 130 degrees F regardless of ambient temperature. Limit acoustic output in elevator machine room and machinery space to 80 dbA.

2.4.1.1 Pump Motor

Provide intermittent-duty pump motor rated at 120 starts/hour. Provide motor that is sized so that the motor amperage does not exceed the motor data tag amperage in any operating condition, exclusive of acceleration and deceleration. Provide minimum of one mega ohm insulation resistance between conductors and motor frame. Provide motor and pump nameplate and data tags permanently mounted on the outside of the pump unit frame, with all data viewable without the use of mirrors or other tools.

2.4.2 Hydraulic Controls and Equipment

Provide control valve, overspeed safety valve, blowout-proof muffler, and hydraulic pump discharge strainer in the hydraulic oil supply line. Provide two 1/4 turn, ball valve type manual shutoff valves. Provide one in the elevator hoistway pit and one in the elevator machine room or machinery space.

2.4.2.1 Hydraulic Control Valve

Provide constant-velocity, down-speed regulated, control valve. Down-speed regulated control valve allows the car to travel at the same speed in the down direction, regardless of the load on the elevator. In addition, the hydraulic control valve must have built-in adjustment capability to operate the elevator at 140 percent of rated speed to facilitate periodic testing of the overspeed safety valve.

2.4.2.2 Hydraulic Overspeed Safety Valve

Provide overspeed safety valve in hydraulic oil supply line, directly adjacent to the hydraulic cylinder. Provide threaded pipe connections between the hydraulic cylinder and the overspeed valve. Provide valve equipped with manufacturer's manual shutoff feature. Overspeed valve must not be equipped with a manual or automatic lowering feature. Provide adjustable valve with means to seal adjustment after inspection and testing by certified elevator inspector.

2.4.3 Hydraulic Piping and Accessories

Provide ASTM A53/A53M or ASTM A106/A106M, Schedule 80, black steel piping with ASME B16.9 or ASME B16.11 fittings for supply piping. Extend schedule 80 piping from the pump control valve body, inside the pump unit, to the hydraulic cylinder in the hoistway. Provide welded or threaded forged pipe fittings for all fittings and components of the hydraulic oil supply line. For in-ground direct plunger cylinders, provide dielectric union or isolation couplings at each end of the hydraulic oil supply line. Provide hangers or supports for all piping and components.

2.4.3.1 Containment of Hydraulic Oil Supply Line

Protect all portions of hydraulic oil supply line that are installed below ground, including portions encapsulated in concrete or covered by construction, with continuous, Schedule 80, PVC. Inside diameter of PVC must be 3 inches larger than the outside diameter of the hydraulic oil supply line pipe and couplings.

2.4.4 Hydraulic Elevator Type

Provide a in-ground direct plunger direct plunger type hydraulic elevator. Elevators with telescopic or inverted cylinder-plungers are not acceptable and may not be used. Rope hydraulic elevator design is not acceptable and may not be used.

2.4.4.1 Cylinder-Plunger (Jack) Unit

Provide a single-stage plunger of seamless steel construction. Provide cylinder with self-stabilizing mount that will support and hold cylinder plumb without the need for stabilization means at the bottom of the cylinder. Provide a threaded, 1/4 inch bleeder valve at the top of the cylinder, just below packing gland.

2.4.5 Cylinder Well System

For direct plunger, in-ground type hydraulic elevator, provide a dry, sealed cylinder well system.

2.4.5.1 Well Casing

Locate and drill well for the cylinder well system. Line well with steel casing, minimum 1/4 inch wall with welded 1/2 inch steel bottom. Set casing plumb.

2.4.5.2 PVC or HDPE Liner

Provide Schedule 80 PVC or HDPE liner with bottom cap and couplings; joints sealed watertight using pipe manufacturer's recommended adhesive or heat welding methods. Provide liner inside diameter not less than 3 inches larger than elevator cylinder maximum outside diameter. Liner may be provided as a cylinder manufacture's applied liner or as a separate component. For separate liner, set liner plumb in well casing, located for cylinder installation. Provide dry, salt-free sand below and around liner to top of well casing.

2.4.5.3 Cylinder Installation

Remove all moisture from inside of liner. Install cylinder plumb, inside liner. Provide a 1/4 inch copper evacuation tube inside the liner. The bottom of the evacuation tube must be within 6 inch of the bottom of the liner. Top of evacuation tube must extend at least 6 inch above pit floor. Provide top of test tube with removable cap to exclude foreign matter. Provide air inlet pressure fitting in top of liner and accessible in pit, for performance of air pressure test. Secure Liner/Cylinder Assembly as recommended by cylinder manufacturer.

2.4.5.4 Cylinder Liner Moisture Sensor System

Provide moisture and oil sensors inside the cylinder liner for detection of oil and water at the bottom of the cylinder liner. Provide sensor monitoring system that will actuate audible and visual alarms and identify the presence of water and identify the presence of oil inside the liner.

2.4.5.5 Seal Top of Well Casing

Upon successful test and certification of Liner/Cylinder assembly, seal gap between steel well casing and liner with foam insert strong enough to retain and support final grouting. Provide 3000 psi grout to a minimum of 4 inch thickness and level top of final grouting with pit floor.

2.5 CONTROL EQUIPMENT

Enclose all elevator control equipment in factory-primed and baked-enamel coated sheet-metal cabinets with ventilation louvers and removable or hinged doors. Mount cabinets at a height of 10 inches above machine room or control room finish floor.

2.5.1 Motor Control Equipment

Provide elevator motor control with electronic, soft-start motor starter.

2.5.2 Elevator Microprocessor Controller

For each individual elevator controller, and for each group controller, provide a microprocessor controller that complies with the following paragraphs. Provide controller(s) package that includes all hardware and software required for the installation, maintenance, and service of the

elevator, in its' entirety. Provide verification of technical support service that the controller manufacturer provides to any licensed elevator installation, service, and maintenance company.

Provide an elevator controller from a manufacturer that provides comprehensive factory training to include controller installation, adjustment, service, and maintenance. The training must be identified as available to any licensed elevator contractor. Provide verification of an established and documented training schedule, with pricing, for factory training classes that manufacturer has provided for a minimum period of one year prior to contract award date.

The elevator controller must be identified as available for purchase and installation by any licensed elevator contractor. All components, parts, diagnostic tools, and software must be available for purchase and installation and use by any licensed elevator contractor; "exchange-only" provisions for the purchase of spare parts are not acceptable. The elevator controller manufacturer must publish an industry competitive price listing for all controller parts, diagnostic tools, and software.

Provide verification of telephone and internet based technical support service that the elevator controller manufacturer provides to any licensed elevator installation, service, and maintenance company at an industry competitive price. The service must include live telephone based technical support for installation, adjustment, maintenance, and troubleshooting of the elevator controller and related elevator components. The service must be available during standard working hours.

Provide an elevator controller that is designed to automatically reestablish normal elevator operation following any temporary loss of power, regardless of duration.

2.5.2.1 Elevator Controller Interface Cabinet

For each individual elevator microprocessor controller, provide a separate elevator control cabinet with an integrated human interface system. For group elevator installations, a single cabinet and interface system with full access to each elevator controller may be utilized. The separate controller interface cabinet must be supplied by the elevator controller manufacturer and include a minimum 12 inch wide keyboard and a minimum 10 inch monitor. The elevator controller interface cabinet must comply with arc-flash protection requirements of NFPA 70E and UFC 3-560-01.

2.5.2.1.1 Elevator Microprocessor Human Interface

The interface system must provide complete elevator controller interface capability and must include the elevator controller manufacturer's comprehensive package of installation and diagnostic software. The microprocessor interface system must provide unrestricted access to all parameters, all levels of adjustment, and all flags necessary for installation, adjustment, maintenance, and troubleshooting of each elevator and for the elevator group. All software programming must be stored in non-volatile memory. The elevator controller fault log must provide non-volatile memory fault log storage of all faults, trouble calls, and fault history for a minimum of one year and the ability to download or print the fault log. The controller interface must also provide the capability to display and diagnose trouble calls, faults, and shutdowns. Expiring software, degrading operation, and "key" access controls are not acceptable.

2.5.2.2 Software and Documentation

Provide three copies of the manufacturer's maintenance and service diagnostic software, with complete software documentation, that will enable the same level of unrestricted access to all controllers of the same make and model, regardless of the installation date or location. Provide signed certification, from the manufacturer's corporate headquarters, that guarantees that the microprocessor software and access system will not terminate the unlimited and unrestricted access at any future date.

2.5.2.3 Elevator Controller Certification

For elevator installations in the United States, including United States territories, provide an elevator microprocessor controller that has a current certificate of safety code compliance issued by the Technical Standards and Safety Authority (TSSA), Toronto, Canada.

2.6 OPERATING PANELS, SIGNAL FIXTURES, AND COMMUNICATIONS CABINETS

For all panels and fixtures, provide identical and uniform panel and fixture design, material, finish, and components for all elevators. For all panels and fixtures, legibly and indelibly identify all buttons, devices, and all operating positions for each device. Use engraving and backfilling, or photo etching, for button and device designations. Do not use attached signs. Provide elevator manufacturers' standard grade for all key switches unless otherwise specified. All illuminating panels and fixture components must utilize LED lighting for energy efficiency.

2.6.1 Car and Hall Buttons

For all cab and landing fixture buttons, provide industry-standard, vandal resistant push buttons with positive-stop assembly design. Buttons must be minimum 3/4 inch diameter, satin-finish stainless steel, with illuminating LED halo.

2.6.2 Passenger Car-Operating Panel

Provide each car with one car operating panels that contains operation controls and communication devices. Provide exposed, flush mounted buttons for the controls identified in subparagraph PASSENGER CONTROLS. Provide a lockable service cabinet for the controls listed in subparagraph SERVICE CONTROLS. Use engraving and backfilling or photo etching for button and switch designations. Do not use attached signs.

2.6.2.1 Passenger Controls

In addition to ASME A17.1/CSA B44 requirements, provide the following operating controls, identified as indicated:

a. Illuminating car-call buttons identified to correspond to landings served by the elevator.

b. "DOOR OPEN" and "DOOR CLOSE" buttons. For front and rear openings at the same floor, include the identification "F" and "R" for each opening.

c. Red, illuminating "ALARM" button.

d. Key-operated "Independent Service" switch.

e. "Help" communication device to include communication between elevator cab and elevator machine room or control room.

2.6.2.2 Service Controls

In addition to ASME A17.1/CSA B44 requirements, provide the following operating controls, identified as indicated:

a. Provide a key-operated, three-position switch for "In car Inspection Operation" and "Hoistway Access". The center switch position will provide normal, automatic operation.

b. "Car Light" switch.

c. "Car Fan" switch with two speed settings identified.

d. 120-volt ac 60 Hz single-phase duplex electrical outlet of ground-fault-circuit-interrupt (GFCI) design.

2.6.2.3 Certificate Window

Provide a minimum 4 inch wide by 6 inch high certificate window for elevator inspection certificate. Locate window in the Service Controls door of the Car Operating Panel.

2.6.2.4 Emergency Signaling Devices

Provide an audible signaling device, operable from the Car Operating Panel button marked "ALARM". The audible signaling device must have a sound pressure rating between 80 and 90 dBA at 10 ft. Provide battery backup power capable of operating the audible signaling device for at least one hour.

2.6.3 Elevator In-Car Position Indicators

For all elevators, provide illuminating position indicator in the Car Operating Panel.

2.6.4 Elevator In-Car Direction Indicators

Provide visual direction indicators and audible car arrival signal in the elevator car door jamb, in accordance with ABA Standards. Visual indicators must be visible from the hall call fixture.

2.6.5 Hall Call Landing Fixtures

Provide a hall call fixture adjacent to each elevator. Provide a single push-button for terminal landings and dual push-buttons, up and down, at intermediate landings.

2.6.5.1 Designated Landing Hall Call Fixture

2.6.5.1.1 Location of COMMUNICATION MEANS FAILURE (CMF) Visual Signal

When required by ASME A17.1/CSA B44, provide an elevator CMF audible and illuminating signal, and reset switch, in the FEO Designated Landing hall

call fixture. Mount the signal and reset switch at a minimum of 7 inches above the "UP" hall call button.

2.6.5.1.2 COMMUNICATION MEANS FAILURE (CMF) Visual and Audible Signal Operation

Provide a CMF visual and audible signal system that conforms to ASME A17.1/CSA B44. Provide continuous verification of operability of the telephone line and immediate activation of audible and visual signals when verification means determines that the telephone line is not functioning. Provide illumination of visual signal at one second intervals. Provide a minimum of 65 dBA audible signal at 30 second intervals.

2.6.5.1.3 Firefighters' Emergency Operation Phase I Switch and Visual Signal

When required by ASME A17.1/CSA B44, provide an elevator Firefighters' Emergency Operation Phase I switch and illuminating visual signal in the FEO Designated Landing hall call fixture. Provide FEO Phase I visual signal that is designed with intermittent, flashing, illumination when actuated by the machine room, control room, or hoistway fire alarm initiating device. Locate FEO Phase I key switch above the CMF visual signal with a minimum of 6 inches vertical between the centerlines of the CMF signal and the FEO Phase I key switch. Locate FEO Phase I visual signal directly above the Phase I switch. In addition, locate Elevator Corridor Call Station Pictograph at top of hall call fixture.

2.6.6 Elevator Car Position and Direction Indicators and Car Arrival Signal

For elevator installations with three or more stops, provide a separate hall landing fixture that includes the visual elevator position indicator, visual direction indicators, and audible car arrival signal, in accordance with ABA Standards.

2.6.7 Emergency or Standby Power

When emergency or standby power is provided for elevator operation, provide an elevator emergency power visual indicator that conforms to ASME A17.1/CSA B44. Locate the visual signal in the Firefighters Emergency Operation fixture for each simplex elevator and for each elevator group. When an emergency power selector switch is required, provide switch in a separate, flush mounted fixture located at the designated level, in view of all elevator entrances.

2.7 CAR DOOR EQUIPMENT

2.7.1 Car Door Operator

Provide elevator door operator equipment and circuitry that is designed and installed as discreet communication. Serial communication must not be used for this system.

2.7.2 Infra-red Curtain Unit

Provide Infra-red Curtain Unit (ICU) with multiple infra-red beams that protect to the full height and width of the door opening. Provide door nudging operation.

2.8 PASSENGER ELEVATOR GUIDES, PLATFORM, AND ENCLOSURE

2.8.1 Roller Guides

Provide coil-spring loaded roller guide assemblies in adjustable mountings on each side of car and counterweight frames in accurate alignment at top and bottom of frames.

2.8.2 Car Enclosure Wall Panels, Return Panels, Doors, Entrance Columns, and Transom

Provide 14 Gauge minimum stainless steel cab wall panels and entrance components. Use same material and finish for all hoistway and car entrance assemblies. Apply sound-deadening material on exterior of all cab wall panels.

2.8.3 Car Enclosure Top

Provide reinforced, 12 gauge minimum steel car enclosure top. Provide hinged emergency exit with lock that complies with the seismic risk zone 2 or greater design requirements of ASME A17.1/CSA B44. Locate emergency exit hinge towards the rear of the elevator cab. Design and configure the elevator cab interior ceiling to provide convenient and unobstructed access to, and use of, emergency exit from inside the elevator cab.

2.8.4 Car Door

Provide 16 gauge minimum stainless steel car doors of sandwich construction with flush surfaces on car and landing sides. Provide a minimum of 2 door guide assemblies per door panel, one guide at leading and one at trailing door edge with guides in the sill groove their entire length of travel.

2.8.5 Car Entrance Sill

Provide one piece cast nickel silver entrance sill(s). Set sills level and flush with floor finish. Use same material for hoistway and car entrance sills.

2.8.6 Cab Finish Floor

Provide cab finish floor with top of finish floor flush with the cab sill.

2.8.7 Car Fan

Provide 2-speed fan for car enclosure forced ventilation. Fan must be mounted in the car enclosure top.

2.8.8 Car Lighting

Utilize LED lighting for elevator car interior illumination. Provide a minimum of 10 foot-candles, measured at all areas of the car enclosure floor. Provide automatic car lighting operation that will turn off car lights after 3 minutes of inactivity. Car lights must automatically turn on upon actuation of an elevator car or hall call.

2.8.9 Car Protection Pads and Hooks

Provide fire retardant, hanging car protection pads that provide

protection for all car interior wall panels. Provide permanently installed studs in car that are designed for hanging the car protection pads in the car.

2.9 PASSENGER ELEVATOR HOISTWAY DOORS AND ENTRANCES

Provide hoistway entrance assemblies with a minimum 1-1/2 hour fire rating. Use same material and finish for all hoistway and car entrance assemblies.

2.9.1 Hoistway Entrance Frames

Provide 14 gage minimum stainless steel hoistway entrance frames. Solidly grout uprights of entrance ways to height of 5 feet.

2.9.2 Hoistway Entrance Sills

Provide one-piece cast nickel silver, stainless steel, or white bronze entrance sills. Set top of landing sill flush with top of finish floor. Solidly grout under full length of sill. Use same material for all hoistway and car entrance sills.

2.9.3 Hoistway Entrance Doors

Provide stainless steel non-vision construction hoistway entrance doors with flush surfaces on car and landing sides. Provide a minimum of 2 door guide assemblies per door panel, one guide at leading edge and one at trailing edge with guides in the sill groove the entire length of door travel. Use same material and finish for all hoistway and car entrance assemblies.

2.9.4 Hoistway Entrance Door Track Dust Covers

Provide sheet metal hoistway door track dust covers at each landing. Dust covers must cover top and hoistway side of door locks and door roller tracks, and extend the full width of the door track and associated hardware. Dust cover sections will not exceed 3 feet in length.

2.10 HOISTWAY EQUIPMENT

2.10.1 Car Guide Rails and Fastenings

Provide T-section type guide rails for car. Paint rail shanks with one coat of black enamel.

2.10.2 Pit Equipment and Support Channels

Provide rail-to-rail pit channels to serve as mounting surface for main guide rails , hydraulic cylinder and car buffers. Method of installation of channels, brackets and buffer mounts must be such that pit waterproofing is not punctured.

2.10.3 Pit "STOP" Switch

Provide push-to-stop/pull-to-run type pit "STOP" switch.

2.10.4 Traveling Cables

Suspend traveling cables by means of self-tightening webbed devices or

internal suspension members.

2.10.5 Hoistway Pit Ladder

Provide continuous horizontal rungs for the full height of the pit ladder.

2.11 COMMERCIAL WHEELCHAIR LIFT

Provide exterior grade, non-skid 36"x54" straight-through platform wheelchair lift with the following criteria:

a. Rated Load: 750 lbs.

b. Drive: Belt driven Ball screw/90 VDC hp motor with brake and 24 VDC battery powered.

c. Power: 120 VAC 15A ground circuit or 240 VAC.

d. Speed: Estimated Average 10 fpm.

e. Controls: Constant pressure paddle switch with emergency stop and key switch.

f. Manual Lowering

g. Safety Design: ASME A18.1, Section 2 - Vertical Platform Lifts.

h. Standards: ASME A17.5/CSA B44.1 - elevator and Escalator Equipment ETL Listed 3148125.

i. Safety Features: Safety pan, final limit, ball nut safety backup, belt monitor and non skid surface.

j. Warranty: 2-year parts.

k. Auto-folding ramp.

l. Solid 42: high guard panels and grab bar.

m. Platform and upper landing gate.

n. Standard manufacturer's white color finish.

o. 53" lifting height.

p. Commercial Wheelchair Lift, Data Package 4

2.11.1 Commercial Wheelchair Lift Codes

Commercial wheelchair lift and lift installation to comply with all applicable national and local codes including:

- 2010 ADA Standards for accessible design
- 2004 ADAAG (ADA Accessibility Guidelines)
- 2015 Architectural Barriers Act (ABA) Standards
- ICC A117.1 .“Accessible and Usable Buildings and Facilities Code"
- ASME A18.1 .“Safety Standard for Platform Lifts and Stairway Lifts”

2.12 Sub Title

PART 3 EXECUTION

3.1 INSTALLATION

Install in accordance with DOD design criteria, contract specifications, manufacturer's instructions, NEII-1 Building Transportation Standards and Guidelines, and all applicable building and safety code requirements.

3.1.1 Structural Members and Finish Materials

Do not cut or alter structural members. Do not alter finish materials from manufacturer's original design. Restore any damaged or defaced work to original condition.

3.1.2 Miscellaneous Requirements

Provide recesses, cutouts, slots, holes, patching, grouting, and refinishing to accommodate elevator installation. Use core drilling to drill all new holes in concrete. Finish work to be straight, level, and plumb. During installation, protect machinery and equipment from dirt, water, or mechanical damage. At completion, clean all work and spot paint.

3.2 FIELD QUALITY CONTROL

The Contractor will provide and utilize a third-party licensed and certified Qualified Elevator Inspector (QEI) to conduct elevator pre-acceptance inspection and testing. The QEI must perform inspections and witness tests to ensure that the installation conforms to all applicable safety codes and contract requirements. The QEI will be directly employed by the Contractor and independent of the elevator contractor.

Upon completion, the QEI must provide written test data for all ASME A17.1/CSA B44 Acceptance Tests and written certification that the elevator is complete and ready for final Acceptance Inspection, Testing, and Commissioning.

3.3 ACCEPTANCE INSPECTION, TESTING AND COMMISSIONING

When elevator system installation is complete and ready for final inspection, notify Contracting Officer that elevator system is ready for Acceptance Inspection, Testing, and Commissioning. Provide QEI certification specified in Article FIELD QUALITY CONTROL.

Contracting Officer will obtain the services of a third-party QEI Certified Elevator Inspector. The QEI must utilize an Elevator Acceptance Inspection Form to record the results of inspection and all testing and to identify safety code and contract deficiencies. Specific values must be provided for all tests required by ASME A17.1/CSA B44, ASME A17.2, and contract documents. Upon completion of inspection and testing, the QEI must sign a copy of the completed forms and provide to the Contracting Officer. Within 2 weeks of the inspection, the QEI must also prepare a formal inspection report, including all test results and deficiencies. Upon successful completion of inspection and testing, the QEI will complete, sign, and provide a certificate of compliance with ASME A17.1/CSA B44.

3.3.1 Acceptance Inspection Support

Prime and Elevator Contractors must provide inspection support and perform all required tests, in order to demonstrate proper operation of each elevator system and to prove that each system complies with contract requirements and all applicable building and safety codes. Inspection procedures in ASME A17.2 form a part of this inspection and acceptance testing. All inspection and testing must be conducted in the presence of the Qualified Elevator Inspector (QEI).

If the elevator does not comply with all contract and safety code requirements on the initial Acceptance Inspection and Test, the Contractor is responsible for all costs involved with re-inspection and re-testing required as a result of contractor delays and discrepancies discovered during inspection and testing.

3.3.2 Testing Materials and Instruments

Furnish all testing materials and instruments necessary for Acceptance Inspection, Testing and Commissioning. At a minimum, include calibrated test weights, tachometer, accelerometer, hydraulic pressure gauge, 600-volt mega ohm meter, volt meter and ammeter, infrared temperature gauge, door pressure gage, dynamometer, and 20 foot tape measure.

3.3.3 Field Tests

3.3.3.1 Endurance Tests

Test each elevator for a period of one hour continuous, automatic operation, with specified rated load in the elevator cab. During the one hour test, stop car at each floor, in both directions of travel, and allow automatic door open and close operation. The requirements for Automatic Operation, Rated Speed, Leveling, Temperature Rise and Motor Amperes must be met throughout the duration of the Endurance Test. Restart the one hour test period from the beginning, following any shutdown or failure.

3.3.3.2 Speed Tests

Determine actual speed of each elevator, in both directions of travel, with rated load and with no load in elevator car. Make Speed tests at the beginning and at the end of the Endurance test. Determine speed by tachometer reading or accelerometer, excluding accelerating and slow-down zones. Under all conditions, minimum acceptable elevator speed is the Rated speed specified. Maximum acceptable elevator speed is 110 percent of Rated speed.

3.3.3.3 Leveling Tests

Test elevator car leveling operation and provide a leveling accuracy equal to or less than 1/8 inch at each floor with no load in car, and with rated load in car, in both directions of travel. Determine leveling accuracy at the beginning and at the end of the endurance tests.

3.3.3.4 Temperature Rise Tests

Determine temperature rise of elevator pump motor and hydraulic fluid during one-hour full-load test run. Under these conditions, maximum temperature rise must not exceed acceptable temperature rise indicated on manufacturer's data plate. Start test only when equipment is within 5

degrees C of ambient temperature.

3.3.3.5 Motor Ampere Tests

At beginning and end of Endurance test, measure and record motor amperage in both directions of travel and in both no-load and rated load conditions.

3.3.3.6 Elevator Performance and Ride Quality Testing

Evaluate elevator performance to ensure compliance with specification requirements related to the NEII-1 Performance Standards Matrix for New Elevator Installations.

3.3.3.7 Hydraulic Safety Valve (Automatic Shutoff Valve) Tests

In order to ensure consistent performance, regardless of hydraulic oil temperature, test the Hydraulic Safety Valve twice. Test once before the one-hour endurance test and once immediately after the one-hour test. For elevator certification, safety valve must perform to code in both tests.

3.3.3.8 Hydraulic Pressure Tests

Check the hydraulic static pressure and rated-speed operating pressure at the hydraulic control valve, under both no load and rated load conditions.

3.3.3.9 Pressure Test of Liner/Cylinder Assembly

Perform 20 psig pressure test of the completed and installed liner/cylinder assembly. Test liner/cylinder assembly as a sealed unit. Provide safety relief valve set to relieve at 20 psig; 4.5 inch diameter dial pressure gage scaled for 0 to 50 psig and calibrated to 0.5 percent accuracy; and an air pressure admission throttle and shutoff valve. For safety, pressure test must only be performed when liner and cylinder are fully inserted and assembled in the well casing. Perform the test from remote location outside of the elevator pit. Perform test in the presence of, and witnessed by, a Certified Elevator Inspector.

3.4 Cleaning and Protection

Remove strippable film. Clean exposed surfaces in accordance with manufacturer's instructions. Protect exposed surfaces from damage by subsequent construction.

-- End of Section --

SECTION 21 12 00

STANDPIPE SYSTEMS
05/11

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C651	(2014) Standard for Disinfecting Water Mains

FM GLOBAL (FM)

FM APP GUIDE	(updated on-line) Approval Guide http://www.approvalguide.com/

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 13	(2016; TIA 16-1; TIA 16-2; TIA 16-3 2016; Errata 17-1; Errata 17-2) Standard for the Installation of Sprinkler Systems
NFPA 14	(2019) Standard for the Installation of Standpipes and Hose Systems
NFPA 24	(2016; ERTA 2016) Standard for the Installation of Private Fire Service Mains and Their Appurtenances

UNDERWRITERS LABORATORIES (UL)

UL Fire Prot Dir	(2012) Fire Protection Equipment Directory

1.2 SYSTEM DESCRIPTION

Design and provide new combination wet Class I standpipe and fire sprinkler system for Building 605 (Cullum Hall) as shown.

1.3 SYSTEM DESCRIPTION

System design and manufacturer's products shall be in accordance with the required and advisory provisions of NFPA 14 except as modified herein. Standpipe system shall be designed by hydraulic calculations. Provide sprinkler portion of system under Section 21 13 13.00 20 WET PIPE SPRINKLER SYSTEM, FIRE PROTECTION. Each system shall include materials, accessories, and equipment inside and outside the building necessary to provide each system complete and ready for use. Devices and equipment shall be UL Fire Prot Dir listed or FM APP GUIDE approved for fire protection service. In the publications referred to herein, the advisory provisions shall be considered to be mandatory, as though the word "shall" had been substituted for "should" wherever it appears; reference to the

"authority having jurisdiction" shall be interpreted to mean the Contracting Officer.

1.3.1 Residual Pressure

The minimum residual pressure at the outlet of the most remote 64 mm hose connection shall be 65 psig while the system is discharging at the required design flow rates.

1.3.2 Friction Losses

Calculate losses in piping in accordance with the Hazen-Williams formula with 'C' value of 120 for steel piping and 140 for cement-lined ductile-iron piping.

1.3.3 Water Supply

Base hydraulic calculations on a static pressure of 60 psi (gage) with 1130 gpm available at a residual pressure of 56 psi (gage) at the junction with the existing water distribution piping system. Base hydraulic calculations on operation of fire pump provided in Section 21 30 00 FIRE PUMPS.

1.3.4 Standpipe System Drawings

Prepare in accordance with the requirements for "Plans and Specifications" as specified in NFPA 14. Each drawing shall be 34 by 22 inches. Plans shall be drawn to a scale not less than 1/8 inch scale Do not commence work until the design of each system and the various components have been approved. Show data essential for proper installation of each system. Show details, plan view, elevations, and sections of the systems supply and piping. Show piping schematic of systems supply, devices, valves, pipe, and fittings. Submit drawings signed by a registered fire protection engineer. Show:

a. Room, space or area layout and include pipe supports and hangers.

b. Field wiring diagrams showing locations of devices and points of connection and terminals used for all electrical field connections in the system, with wiring color code scheme.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submittals with an "AE" are for submittal to the Designer of Record. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

The fire protection engineer, and Contracting Office will review any approve all submittals in this section requiring Government approval.

SD-02 Shop Drawings

Standpipe system; G, AE

SD-03 Product Data

Aboveground Pipe and fittings; G, AE

Mechanical couplings; G, AE

Pipe hangers and supports; G, AE

Valves, including gate, check, and hose; G, AE

Data which describes more than one type of item shall be clearly marked to indicate which type the Contractor intends to provide. Submit one original for each item and clear, legible, first-generation photocopies for the remainder of the specified copies. Incomplete or illegible photocopies will not be accepted. Partial submittals will not be accepted.

SD-06 Test Reports

Preliminary tests; G, AE

Acceptance tests; G, AE

Submit for all inspections and tests specified under paragraph entitled "Field Quality Control."

SD-07 Certificates

Qualifications of installer; G, AE

Submit installers qualifications as required under paragraph entitled "Qualifications of Installer."

SD-11 Closeout Submittals

System as-built drawings; G, AE

1.5 QUALITY ASSURANCE

1.5.1 Qualifications of Installer

Prior to commencing work, submit data showing that the Contractor has successfully installed fire extinguishing standpipe systems of the same type and design as specified herein, or that he has a firm contractual agreement with a subcontractor having the required experience. Include the names and locations of at least two installations where the Contractor, or the subcontractor referred to above, has installed such systems. Indicate the type and design of each system, and certify that the system has performed satisfactorily for a period of at least 18 months.

Qualifications of System Technician: Installation drawings, shop drawing and as-built drawings shall be prepared, by or under the supervision of, an individual who is experienced with the types of works specified herein, and is currently a licensed fire protection engineer. Contractor shall submit data for approval showing the name and certification of all involved individuals with such qualifications at or prior to submittal of drawings.

1.5.2 System As-Built Drawings

Upon completion, and before final acceptance of the work, submit a complete set of as-built drawings of each system. Submit 34 by 22 inch reproducible as-built drawings on mylar film with title block similar to full size contract drawings. Furnish as-built(record) working drawings in addition to the as-built drawings required by Division 1, "General Requirements."

1.6 DELIVERY, STORAGE AND HANDLING

Protect stored equipment from weather, humidity and temperature variations, dirt, dust, and other contaminants.

PART 2 PRODUCTS

2.1 ABOVEGROUND PIPING SYSTEMS

Provide fittings for changes in direction of piping and for connections. Make changes in piping sizes through tapered reducing pipe fittings; bushings will not be permitted. Perform welding in the shop; field welding will not be permitted. Conceal piping in areas with suspended ceiling.

2.1.1 Pipe and Fittings

NFPA 14, except as modified herein. Steel piping shall be Schedule 40 for sizes less than 8 inches, and Schedule 30 or 40 for sizes 8 inches and larger. Fittings shall be welded, threaded, or grooved-end type. Plain-end fittings with mechanical couplings and fittings which use steel gripping devices to bite into the pipe when pressure is applied will not be permitted. Rubber gasketed grooved-end pipe and fittings with mechanical couplings shall be permitted in pipe sizes 1.5 inches and larger. Fittings shall be UL Fire Prot Dir listed or FM APP GUIDE approved for use in wet pipe sprinkler systems. Fittings, mechanical couplings, and rubber gaskets shall be supplied by the same manufacturer. Steel piping with wall thickness less than Schedule 30 shall not be threaded. Side outlet tees using rubber gasketed fittings shall not be permitted. Pipe and fittings shall be metal.

2.1.2 Pipe Hangers and Supports

Provide in accordance with NFPA 14.

2.1.3 Valves

NFPA 14. Provide valves of types approved for fire service. Hose and gate valves shall open by counterclockwise rotation. Provide isolation and check valves as required by NFPA 14. Isolation valves shall be OS&Y type. Check valves shall be flanged clear opening swing-check type with flanged inspection and access cover plate for sizes 4 inches and larger.

2.1.3.1 Hose Valves

Provide bronze hose valve with 2 1/2 inch National Standard male hose threads, with cap and chain.

2.1.4 Identification Signs

NFPA 14. Attach properly lettered and approved metal signs to each valve and alarm device.

2.1.5 Main Drains

Provide separate drain piping to discharge at safe points outside each building or to sight cones attached to drains of adequate size to readily receive the full flow from each drain under maximum pressure. Provide auxiliary drains as required by NFPA 13 and NFPA 14.

2.1.6 Pipe Sleeves

Provide where piping passes entirely through walls, floors, roofs and partitions. Secure sleeves in position and location during construction. Provide sleeves of sufficient length to pass through entire thickness of walls, floors, roofs and partitions. Provide one inch minimum clearance between exterior of piping and interior of sleeve or core-drilled hole. Firmly pack space with mineral wool insulation. Seal space at both ends of the sleeve or core-drilled hole with plastic waterproof cement which will dry to a firm but pliable mass, or provide a mechanically adjustable segmented elastomeric seal. In fire walls and fire floors, seal both ends of pipe sleeves or core-drilled holes with UL listed fill, void, or cavity material.

2.1.6.1 Sleeves in Masonry and Concrete Walls, Floors, and Roofs

Provide hot-dip galvanized steel, ductile-iron, or cast-iron sleeves. Core drilling of masonry and concrete may be provided in lieu of pipe sleeves when cavities in the core-drilled hole are completely grouted smooth. Extend sleeves in floor slabs 3 inches above finished floors.

2.1.6.2 Sleeves in Partitions

Provide 26 gage galvanized steel sheet.

2.1.7 Escutcheon Plates

Provide one piece or split hinge type metal plates for piping passing through walls, floors, and ceilings in both exposed and concealed spaces. Provide polished stainless steel plates or chromium-plated finish on copper alloy plates in finished spaces. Provide paint finish on metal plates in unfinished spaces. Securely anchor plates in place.

2.1.8 Fire Pumps

Provide as specified in Section 21 30 00 FIRE PUMPS.

2.2 ELECTRICAL WORK

Provide electrical work associated with this section under Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM, except for fire alarm wiring. Provide fire alarm wiring and connection to fire alarm systems under Section 28 31 76 INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM..

PART 3 EXECUTION

3.1 CONNECTIONS TO EXISTING WATER SUPPLY SYSTEMS

Connections to existing water supply system are specified in ~~Section 33 12 16.17 WATER UTILITY DISTRIBUTION PIPING~~the American Water specifications attached within Appendix 4 of the project specifications.

3.2 STANDPIPE SYSTEM INSTALLATION

Equipment, materials, installation, workmanship, fabrication, assembly, erection, examination, inspection, and testing shall be in accordance with the NFPA standards referenced herein. Install piping straight and true to bear evenly on hangers and supports. Conceal piping to the maximum extent possible. Piping shall be inspected, tested and approved before being concealed. Provide fittings for changes in direction of piping and for all connections Make changes in piping sizes through standard reducing pipe fittings; do not use bushings. Cut pipe accurately and work into place without springing or forcing. Ream pipe ends and free pipe and fittings from burrs. Clean with solvent to remove all varnish and cutting oil prior to assemble. Make screw joints with PTFE tape applied to male thread only.

3.3 DISINFECTION

Disinfect new water piping from the point of connection at the water main and existing water piping affected by the Contractor's operation in accordance with AWWA C651. Exercise caution when mixing chlorine disinfectant solutions. Fill piping systems with solution containing minimum of 50 parts per million of free available chlorine and allow solution to stand for a minimum of 24 hours. Flush solution from systems with clean water until maximum residual chlorine content is not greater than 0.2 parts per million. Obtain at least two consecutive satisfactory bacteriological samples from new water piping, analyze by a certified laboratory, and submit results prior to new water piping being placed into service.

3.4 FIELD PAINTING

Field painting of fire extinguishing standpipe system shall be specified in Section 09 90 00 PAINTS AND COATINGS. Field painting requirements for "Fire Extinguishing Sprinkler Systems" shall apply.

3.4.1 Piping Labels

Provide permanent labels in mechanical rooms, spaced at 20 foot maximum intervals along pipe, indicating "STANDPIPE."

3.5 ELECTRICAL WORK

Provide electrical work associated with this section under Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM, except for fire alarm wiring. Provide fire alarm wiring and connection to fire alarm systems under Section 28 31 76 INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM.

3.6 FLUSHING

Flush the piping system with potable water in accordance with NFPA 14. Continue flushing operation until water is clear, but for not less than 10

minutes.

3.7 FIELD QUALITY CONTROL

Prior to initial operation, inspect equipment and piping systems for compliance with drawings, specifications, and manufacturer's submittals. Perform tests in the presence of the Contracting Officer to determine conformance with the specified requirements.

3.7.1 Preliminary Tests

Each piping system shall be hydrostatically tested at 200 psig in accordance with NFPA 14 and NFPA 24 and shall show no leakage or reduction in gauge pressure after 2 hours. The Contractor shall conduct complete preliminary tests, which shall encompass all aspects of system operation. When tests have been completed and all necessary corrections made, submit to the Contracting Officer a signed and dated certificate, similar to that specified in NFPA 13, attesting to the satisfactory completion of all testing and stating that the system is in operating condition. Also include a written request for a formal inspection and test.

3.7.2 Formal Inspection and Tests (Acceptance Tests)

The Contracting Office, will witness formal tests and approve all systems before they are accepted. The system shall be considered ready for such testing only after all necessary preliminary tests have been made and all deficiencies found have been corrected to the satisfaction of the Contracting Officer and written certification to this effect is received by the Division Fire Protection Engineer. Submit the request for formal inspection at least 15 working days prior to the date the inspection is to take place. Experienced technicians regularly employed by the Contractor in the installation of both the mechanical and electrical portions of such systems shall be present during the inspection and shall conduct the testing. All instruments, personnel, appliances and equipment for testing shall be furnished by the Contractor. The Government will furnish water for the tests. All necessary tests encompassing all aspects of system operation shall be made including the following, and any deficiency found shall be corrected and the system retested at no cost to the Government.

3.7.2.1 Flow Test

Perform flow tests of each standpipe riser in accordance with NFPA 14. Affix 0-300 psi pressure gauges to lowest hose valve and next-to-highest hose valve. Connect lined, 2 1/2 inch diameter fire hose with underwriter's playpipe to highest hose valve and flow at least 250 gpm for 5 minutes from standpipe to a safe location outside the building. Furnish hose, nozzles and fittings required for this test.

3.7.3 Additional Tests

When deficiencies, defects or malfunctions develop during the tests required, all further testing of the system shall be suspended until proper adjustments, corrections or revisions have been made to assure proper performance of the system. If these revisions require more than a

nominal delay, the Contracting Officer shall be notified when the additional work has been completed, to arrange a new inspection and test of the system. All tests required shall be repeated prior to final acceptance, unless directed otherwise.

-- End of Section --

SECTION 21 13 13.00 10

WET PIPE SPRINKLER SYSTEM, FIRE PROTECTION
05/09

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1015	(2011) Performance Requirements for Double Check Backflow Prevention Assemblies and Double Check Fire Protection Backflow Prevention Assemblies - (ANSI approved 2010)

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C104/A21.4	(2016) Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
AWWA C110/A21.10	(2012) Ductile-Iron and Gray-Iron Fittings for Water
AWWA C111/A21.11	(2017) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C151/A21.51	(2017) Ductile-Iron Pipe, Centrifugally Cast
AWWA C203	(2008) Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot-Applied

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.1	(2015) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250
ASME B16.3	(2016) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.4	(2014) Standard for Gray Iron Threaded Fittings; Classes 125 and 250
ASME B16.9	(2018) Factory-Made Wrought Buttwelding Fittings
ASME B16.11	(2016) Forged Fittings, Socket-Welding and Threaded
ASME B16.21	(2016) Nonmetallic Flat Gaskets for Pipe

	Flanges
ASME B18.2.2	(2015) Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)

ASTM INTERNATIONAL (ASTM)

ASTM A47/A47M	(1999; R 2018; E 2018) Standard Specification for Ferritic Malleable Iron Castings
ASTM A53/A53M	(2020) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A135/A135M	(2009; R2014) Standard Specification for Electric-Resistance-Welded Steel Pipe
ASTM A183	(2014) Standard Specification for Carbon Steel Track Bolts and Nuts
ASTM A449	(2014) Standard Specification for Hex Cap Screws, Bolts, and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use
ASTM A536	(1984; R 2019; E 2019) Standard Specification for Ductile Iron Castings
ASTM A795/A795M	(2013; R 2020) Standard Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use
ASTM F436	(2011) Hardened Steel Washers

FM GLOBAL (FM)

FM 1637	(2010) Flexible Sprinkler Hose with Threaded End Fittings
FM APP GUIDE	(updated on-line) Approval Guide http://www.approvalguide.com/

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-71	(2018) Gray Iron Swing Check Valves, Flanged and Threaded Ends

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 13	(2016; TIA 16-1; TIA 16-2; TIA 16-3 2016; Errata 17-1; Errata 17-2) Standard for the Installation of Sprinkler Systems
NFPA 24	(2016; ERTA 2016) Standard for the Installation of Private Fire Service Mains

	and Their Appurtenances
NFPA 1963	(2019) Standard for Fire Hose Connections

UNDERWRITERS LABORATORIES (UL)

UL 668	(2004; Reprint Jul 2016) UL Standard for Safety Hose Valves for Fire-Protection Service
UL 2443	(2015; Reprint May 2020) UL Standard for Safety Flexible Sprinkler Hose with Fitings for Fire Protection Service
UL Bld Mat Dir	(updated continuously online) Building Materials Directory
UL Fire Prot Dir	(2012) Fire Protection Equipment Directory

1.2 SYSTEM DESCRIPTION

Furnish piping offsets, fittings, and any other accessories as required to provide a complete installation and to eliminate interference with other construction. Install sprinkler system over and under ducts, piping and platforms when such equipment can negatively effect or disrupt the sprinkler discharge pattern and coverage. Provide wet pipe sprinkler system in areas indicated on the drawings. Except as modified herein, the system shall be designed and installed in accordance with NFPA 13. Pipe sizes which are not indicated on drawings shall be determined by hydraulic calculation. Design any portions of the sprinkler system that are not indicated on the drawings including locating sprinklers, piping and equipment, and size piping and equipment when this information is not indicated on the drawings or is not specified herein. The design of the sprinkler system shall be based on hydraulic calculations, and the other provisions specified herein.

1.2.1 Hydraulic Design

Hydraulically design the system to discharge a minimum density as indicated on the drawings. The minimum pipe size for branch lines in gridded systems shall be 1-1/4 inch. Hydraulic calculations shall be in accordance with the Area/Density Method of NFPA 13. Water velocity in the piping shall not exceed 20 ft/s.

1.2.1.1 Hose Demand

Add an allowance for exterior hose streams of 500 gpm to the sprinkler system demand at the fire hydrant shown on the drawings closest to the point where the water service enters the building.

1.2.1.2 Basis for Calculations

The design of the system shall be based upon a water supply with a static pressure of 60 psi, and a flow of 1130 gpm at a residual pressure of 56 psi. Water supply shall be presumed available at the junction with the existing water distribution piping system. Hydraulic calculations shall be based upon the Hazen-Williams formula with a "C" value of 120 for steel piping, 140 for new cement-lined ductile-iron piping, and 100 for existing underground piping. Hydraulic calculations shall be based on operation of

the fire pump(s) provided in Section 21 30 00 FIRE PUMPS.

1.2.1.3 Hydraulic Calculations

Submit hydraulic calculations, including a drawing showing hydraulic reference points and pipe segments and as outlined in NFPA 13, except that calculations shall be performed by computer using software intended specifically for fire protection system design using the design data shown on the drawings. Software that uses k-factors for typical branch lines is not acceptable. Calculations shall be based on the water supply data shown on the drawings to substantiate that the design area used in the calculations is the most demanding hydraulically. Water supply curves and system requirements shall be plotted on semi-logarithmic graph paper so as to present a summary of the complete hydraulic calculation. Provide a summary sheet listing sprinklers in the design area and their respective hydraulic reference points, elevations, actual discharge pressures and actual flows. Elevations of hydraulic reference points (nodes) shall be indicated. Documentation shall identify each pipe individually and the nodes connected thereto. Indicate the diameter, length, flow, velocity, friction loss, number and type fittings, total friction loss in the pipe, equivalent pipe length and Hazen-Williams coefficient for each pipe. For gridded systems, calculations shall show peaking of demand area friction loss to verify that the hydraulically most demanding area is being used. Also for gridded systems, a flow diagram indicating the quantity and direction of flows shall be included. A drawing showing hydraulic reference points (nodes) and pipe designations used in the calculations shall be included and shall be independent of shop drawings.

1.2.2 Sprinkler Coverage

Sprinklers shall be uniformly spaced on branch lines. In buildings protected by automatic sprinklers, sprinklers shall provide coverage throughout 100 percent of the building. This includes, but is not limited to, telephone rooms, electrical equipment rooms, boiler rooms, switchgear rooms, transformer rooms, and other electrical and mechanical spaces. Coverage per sprinkler shall be in accordance with NFPA 13, but shall not exceed 100 square feet for extra hazard occupancies, 130 square feet for ordinary hazard occupancies, and 225 square feet for light hazard occupancies.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submittals with an "AE" are for submittal to the Designer of Record. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Shop Drawings; G, AE
As-Built Drawings

SD-03 Product Data

Finish Samples for Concealed Sprinkler Cover Plates; G, AE

Fire Protection Related Submittals
Materials and Equipment; G, AE
Spare Parts
Preliminary Tests; G, AE
Final Acceptance Test; G, AE
Onsite Training; G, AE
Fire Protection Specialist; G, AE
Sprinkler System Installer; G, AE

SD-05 Design Data

Sway Bracing; G, AE
Hydraulic Calculations; G, AE

SD-06 Test Reports

Preliminary Test Report
Final Acceptance Test Report

SD-07 Certificates

Inspection by Fire Protection Specialist

SD-10 Operation and Maintenance Data

Operating and Maintenance Manuals; G, AE

1.4 QUALITY ASSURANCE

Compliance with referenced NFPA standards is mandatory. In the event of a conflict between specific provisions of this specification and applicable NFPA standards, this specification governS. Interpret reference to "authority having jurisdiction" to mean the Contracting Officer.

1.4.1 Fire Protection Specialist

Perform work specified in this section under the supervision of and certified by the Fire Protection Specialist who is an individual registered professional engineer who has passed the fire protection engineering written examination administered by the National Council of Examiners for Engineering and Surveys (NCEES). Submit the name and documentation of certification of the proposed Fire Protection Specialists, no later than 14 days after the Notice to Proceed and prior to the submittal of the sprinkler system drawings and hydraulic calculations. The Fire Protection Specialist shall prepare and submit a list of the fire protection related submittals, no later than 7 days after the approval of the Fire Protection Specialist, from the Contract Submittal Register that relate to the successful installation of the sprinkler systems(s). The submittals identified on this list shall be accompanied by a letter of approval signed and dated by the Fire Protection Specialist when submitted to the Government. The Fire Protection Specialist shall be regularly engaged in the design and installation of the type and complexity of system specified in the contract documents, and shall have served in a similar capacity for at least three systems that have performed in the manner intended for a period of not less than 6 months.

1.4.2 Sprinkler System Installer

Work specified in this section shall be performed by the Sprinkler System Installer who is regularly engaged in the installation of the type and complexity of system specified in the contract documents, and who has served in a similar capacity for at least three systems that have performed in the manner intended for a period of not less than 6 months. Submit the name and documentation of certification of the proposed Sprinkler System Installer, concurrent with submittal of the Fire Protection Specialist Qualifications.

1.4.3 Shop Drawings

Shop Drawings shall conform to the requirements established for working plans as prescribed in NFPA 13. Submit 3 copies of the Sprinkler System shop drawings, no later than 21 days prior to the start of sprinkler system installation. Drawings shall include plan and elevation views demonstrating that the equipment will fit the allotted spaces with clearance for installation and maintenance. Each set of drawings shall include the following:

a. Descriptive index of drawings in the submittal with drawings listed in sequence by drawing number. A legend identifying device symbols, nomenclature, and conventions used.

b. Floor plans drawn to a scale not less than 1/8" = 1'-0" which clearly show locations of sprinklers, risers, pipe hangers, seismic separation assemblies, sway bracing, inspector's test connections, drains, and other applicable details necessary to clearly describe the proposed arrangement. Each type of fitting used and the locations of bushings, reducing couplings, and welded joints shall be indicated.

c. Actual center-to-center dimensions between sprinklers on branch lines and between branch lines; from end sprinklers to adjacent walls; from walls to branch lines; from sprinkler feed mains, cross-mains and branch lines to finished floor and roof or ceiling. A detail shall show the dimension from the sprinkler and sprinkler deflector to the ceiling in finished areas.

d. Longitudinal and transverse building sections showing typical branch line and cross-main pipe routing as well as elevation of each typical sprinkler above finished floor.

e. Details of each type of riser assembly; pipe hanger; sway bracing for earthquake protection, and restraint of underground water main at point-of-entry into the building, and electrical devices and interconnecting wiring. Submit load calculations for sizing of sway bracing, for systems that are required to be protected against damage from earthquakes.

1.5 DELIVERY, STORAGE, AND HANDLING

All equipment delivered and placed in storage shall be housed in a manner to preclude any damage from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Additionally, all pipes shall either be capped or plugged until installed.

1.6 EXTRA MATERIALS

Submit spare parts data for each different item of material and equipment specified. The data shall include a complete list of parts and supplies, with current unit prices and source of supply, and a list of parts recommended by the manufacturer to be replaced after 1 year and 3 years of service. Include a list of special tools and test equipment required for maintenance and testing of the products supplied.

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS

Provide materials and equipment which are standard products of a manufacturer regularly engaged in the manufacture of such products and that essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening.

2.2 NAMEPLATES

All equipment shall have a nameplate that identifies the manufacturer's name, address, type or style, model or serial number, and catalog number.

2.3 REQUIREMENTS FOR FIRE PROTECTION SERVICE

Provide Materials and Equipment that have been tested by Underwriters Laboratories, Inc. and are listed in UL Fire Prot Dir or approved by Factory Mutual and listed in FM APP GUIDE. Where the terms "listed" or "approved" appear in this specification, such shall mean listed in UL Fire Prot Dir or FM APP GUIDE. Submit manufacturer's catalog data included with the Sprinkler System Drawings for all items specified herein. The data shall be highlighted to show model, size, options, etc., that are intended for consideration. Data shall be adequate to demonstrate compliance with all contract requirements. In addition, provide a complete equipment list that includes equipment description, model number and quantity.

2.4 UNDERGROUND PIPING COMPONENTS

2.4.1 Pipe

Piping from a point 6 inches above the floor to a point 5 feet outside the building wall shall be ductile iron with a rated working pressure of 175 psi conforming to AWWA C151/A21.51, with cement mortar lining conforming to AWWA C104/A21.4. Piping more than 5 feet outside the building walls shall comply with ~~Section 33 12 16.17 WATER UTILITY DISTRIBUTION PIPING~~the American Water specifications attached within Appendix 4 of the project specifications.

2.4.2 Fittings and Gaskets

Fittings shall be ductile iron conforming to AWWA C110/A21.10 with cement mortar lining conforming to AWWA C104/A21.4. Gaskets shall be suitable in design and size for the pipe with which such gaskets are to be used. Gaskets for ductile iron pipe joints shall conform to AWWA C111/A21.11.

2.4.3 Gate Valve and Indicator Posts

Gate valves for underground installation shall be of the inside screw type

with counter-clockwise rotation to open. Where indicating type valves are shown or required, indicating valves shall be gate valves with an approved indicator post of a length to permit the top of the post to be located 3 feet above finished grade. Gate valves and indicator posts shall be listed in UL Fire Prot Dir or FM APP GUIDE.

2.5 ABOVEGROUND PIPING COMPONENTS

Aboveground piping shall be steel.

2.5.1 Steel Piping Components

2.5.1.1 Steel Pipe

Except as modified herein, steel pipe shall be black as permitted by NFPA 13 and shall conform to applicable provisions of ASTM A795/A795M, ASTM A53/A53M, or ASTM A135/A135M. Pipe in which threads or grooves are cut or rolled formed shall be Schedule 40 or shall be listed by Underwriters' Laboratories to have a corrosion resistance ratio (CRR) of 1.0 or greater after threads or grooves are cut or rolled formed. Pipe shall be marked with the name of the manufacturer, kind of pipe, and ASTM designation.

2.5.1.2 Fittings for Non-Grooved Steel Pipe

Fittings shall be cast iron conforming to ASME B16.4, steel conforming to ASME B16.9 or ASME B16.11, or malleable iron conforming to ASME B16.3. Fittings into which sprinklers, drop nipples or riser nipples (sprigs) are screwed shall be threaded type. Plain-end fittings with mechanical couplings, fittings that use steel gripping devices to bite into the pipe and segmented welded fittings shall not be used.

2.5.1.3 Grooved Mechanical Joints and Fittings

Joints and fittings shall be designed for not less than 175 psi service and shall be the product of the same manufacturer;segmented welded fittings shall not be used. Fitting and coupling houses shall be malleable iron conforming to ASTM A47/A47M, Grade 32510; ductile iron conforming to ASTM A536, Grade 65-45-12. Gasket shall be the flush type that fills the entire cavity between the fitting and the pipe. Nuts and bolts shall be heat-treated steel conforming to ASTM A183 and shall be cadmium plated or zinc electroplated.

2.5.1.4 Flanges

Flanges shall conform to NFPA 13 and ASME B16.1. Gaskets shall be non-asbestos compressed material in accordance with ASME B16.21, 1/16 inch thick, and full face or self-centering flat ring type.

2.5.1.5 Bolts, Nut, and Washers

Bolts shall be conform to ASTM A449, Type 1 and shall extend no less than three full threads beyond the nut with bolts tightened to the required torque. Nuts shall be hexagon type conforming to ASME B18.2.2. Washers shall meet the requirements of ASTM F436. Flat circular washers shall be provided under all bolt heads and nuts.

2.5.2 Pipe Hangers

Hangers shall be listed in UL Fire Prot Dir or FM APP GUIDE and of the type suitable for the application, construction, and pipe type and sized to be supported.

2.5.3 Valves

2.5.3.1 Control Valve and Gate Valve

Manually operated sprinkler control valve and gate valve shall be outside stem and yoke (OS&Y) type and shall be listed in UL Bld Mat Dir or FM APP GUIDE.

2.5.3.2 Check Valve

Check valve 2 inches and larger shall be listed in UL Bld Mat Dir or FM APP GUIDE. Check valves 4 inches and larger shall be of the swing type with flanged cast iron body and flanged inspection plate, shall have a clear waterway and shall meet the requirements of MSS SP-71, for Type 3 or 4.

2.5.3.3 Hose Valve

Valve shall comply with UL 668 and shall have a minimum rating of 300 psi. Valve shall be non-rising stem, all bronze, 90 degree angle type, with 2-1/2 inch American National Standard Fire Hose Screw Thread (NH) male outlet in accordance with NFPA 1963. Hose valves shall be equipped with lugged cap with drip drain, cap gasket and chain. Valve finish shall be polished chrome plated.

2.5.4 Flexible Sprinkler Hose

The use of flexible hose permitted. Flexible sprinkler hose must comply with UL 2443 and FM 1637.

2.6 RISER CHECK VALVE ASSEMBLY

Assembly shall include an check valve, standard trim piping, pressure gauges, testing valves, main drain, and other components as required for a fully operational system.

2.7 WATERFLOW ALARM

Electrically operated, exterior-mounted, waterflow alarm bell shall be provided and installed in accordance with NFPA 13. Waterflow alarm bell shall be rated 24 VDC and shall be connected to the Fire Alarm Control Panel(FACP) in accordance with Section 28 31 76 INTERIOR FIRE ALARM AND MASS NOTIFICATION .

2.8 ALARM INITIATING AND SUPERVISORY DEVICES

2.8.1 Sprinkler Waterflow Indicator Switch, Vane Type

Switch shall be vane type with a pipe saddle and cast aluminum housing. The electro-mechanical device shall include a flexible, low-density polyethylene paddle conforming to the inside diameter of the fire protection pipe. The device shall sense water movements and be capable of detecting a sustained flow of 10 gpm or greater. The device shall contain

a retard device adjustable from 0 to 90 seconds to reduce the possibility of false alarms caused by transient flow surges. The switch shall be tamper resistant and contain two SPDT (Form C) contacts arranged to transfer upon removal of the housing cover, and shall be equipped with a silicone rubber gasket to assure positive water seal and a dustproof cover and gasket to seal the mechanism from dirt and moisture.

2.8.2 Valve Supervisory (Tamper) Switch

Switch shall be suitable for mounting to the type of control valve to be supervised open. The switch shall be tamper resistant and contain one set of SPDT (Form C) contacts arranged to transfer upon removal of the housing cover or closure of the valve of more than two rotations of the valve stem.

2.9 "STORZ" TYPE FIRE DEPARTMENT CONNECTION

Fire department connection shall be Storz type with forged aluminum body, matching wall escutcheon lettered "AUTO SPKR" with polished brass finish. The connection shall have one inlet with individual self-closing clappers, caps with drip drains and chains. 4 inch diameter locking Storz inlet with 4 inch diameter female NPT outlet.

2.10 SPRINKLERS

Sprinklers with internal O-rings shall not be used. Sprinklers shall be used in accordance with their listed coverage limitations. Temperature classification shall be as indicated. Sprinklers in high heat areas including attic spaces or in close proximity to unit heaters shall have temperature classification in accordance with NFPA 13. Custom sprinkler covers as required. Refer to architectural drawings for colors.

2.10.1 Concealed Sprinkler

Concealed sprinkler shall be white polyester quick-response type and shall have a nominal 1/2 inch or 17/32 inch orifice. Provide custom color cover plates in historic areas. Refer to architectural plans for locations and colors. Provide finish samples for concealed sprinkler cover plates as outlined in Section 1.3 Submittals.

2.10.2 Pendent Sprinkler

Pendent sprinkler shall be of the fusible strut or glass bulb type, quick-response type with nominal 1/2 inch or 17/32 inch orifice. Pendent sprinklers shall have a polished chrome finish.

2.10.3 Upright Sprinkler

Upright sprinkler shall be brass quick-response type and shall have a nominal 1/2 inch or 17/32 inch orifice.

2.10.4 Sidewall Sprinkler

Sidewall sprinkler shall have a nominal 1/2 inch orifice. Sidewall sprinkler shall have a polished chrome finish. Sidewall sprinkler shall be the quick-response type.

2.10.5 Dry Sprinkler Assembly

Dry sprinkler assembly shall be of the type as indicated. Assembly shall

include an integral escutcheon. Maximum length shall not exceed maximum indicated in UL Fire Prot Dir. Sprinklers shall have a polished chrome finish. Dry sprinkler assembly shall be a minimum of 24 inches.

2.11 ACCESSORIES

2.11.1 Sprinkler Cabinet

Spare sprinklers shall be provided in accordance with NFPA 13 and shall be packed in a suitable metal or plastic cabinet. Spare sprinklers shall be representative of, and in proportion to, the number of each type and temperature rating of the sprinklers installed. At least one wrench of each type required shall be provided.

2.11.2 Pendent Sprinkler Escutcheon

Escutcheon shall be one-piece metallic type with a depth of less than 3/4 inch and suitable for installation on pendent sprinklers. The escutcheon shall have a factory finish that matches the pendent sprinkler heads.

2.11.3 Pipe Escutcheon

Escutcheon shall be polished chromium-plated zinc alloy, or polished chromium-plated copper alloy. Escutcheons shall be either one-piece or split-pattern, held in place by internal spring tension or set screw.

2.11.4 Sprinkler Guard

Guard shall be a steel wire cage designed to encase the sprinkler and protect it from mechanical damage. Guards shall be provided on sprinklers located as indicated.

2.11.5 Identification Sign

Valve identification sign shall be minimum 6 inches wide by 2 inches high with enamel baked finish on minimum 18 gauge steel or 0.024 inch aluminum with red letters on a white background or white letters on red background. Wording of sign shall include, but not be limited to "main drain," "auxiliary drain," "inspector's test," "alarm test," "alarm line," and similar wording as required to identify operational components.

2.12 DOUBLE-CHECK VALVE BACKFLOW PREVENTION ASSEMBLY

Double-check backflow prevention assembly shall comply with ASSE 1015. The assembly shall have a bronze, cast-iron or stainless steel body with flanged ends. The assembly shall include pressure gauge test ports and OS&Y shutoff valves on the inlet and outlet, 2-positive-seating check valve for continuous pressure application, and four test cocks. Assemblies shall be rated for working pressure of 175 psi The maximum pressure loss shall be 6 psi at a flow rate equal to the sprinkler water demand, at the location of the assembly. A test port for a pressure gauge shall be provided both upstream and downstream of the double check backflow prevention assembly valves.

PART 3 EXECUTION

3.1 FIELD MEASUREMENTS

After becoming familiar with all details of the work, verify all

dimensions in the field, and advise the Contracting Officer of any discrepancy before performing the work.

3.2 INSTALLATION REQUIREMENTS

The installation shall be in accordance with the applicable provisions of NFPA 13, NFPA 24 and publications referenced therein. Installation of in-rack sprinklers shall comply with applicable provisions of NFPA 13.

3.3 INSPECTION BY FIRE PROTECTION SPECIALIST

Prior to ceiling installation and concurrent with the Final Acceptance Test Report, certification by the Fire Protection Specialist that the sprinkler system is installed in accordance with the contract requirements, including signed approval of the Preliminary and Final Acceptance Test Reports. The Fire Protection Specialist shall: 1) inspect the sprinkler system periodically during the installation to assure that the sprinkler system is being provided and installed in accordance with the contract requirements, 2) witness the preliminary and final tests, and sign the test results, 3) after completion of the system inspections and a successful final test, certify in writing that the system has been installed in accordance with the contract requirements. Any discrepancy shall be brought to the attention of the Contracting Officer in writing, no later than three working days after the discrepancy is discovered.

3.4 ABOVEGROUND PIPING INSTALLATION

3.4.1 Piping in Exposed Areas

Install exposed piping without diminishing exit access widths, corridors or equipment access. Exposed horizontal piping, including drain piping, shall be installed to provide maximum headroom.

3.4.2 Piping in Finished Areas

In areas with suspended or dropped ceilings and in areas with concealed spaces above the ceiling, piping shall be concealed above ceilings. Piping shall be inspected, tested and approved before being concealed. Risers and similar vertical runs of piping in finished areas shall be concealed.

3.4.3 Pendent Sprinklers

Drop nipples to pendent sprinklers shall consist of minimum 1 inch pipe with a reducing coupling into which the sprinkler shall be threaded. Hangers shall be provided on arm-overs to drop nipples supplying pendent sprinklers when the arm-over exceeds 12 inches for steel pipe or 6 inches for copper tubing. Where sprinklers are installed below suspended or dropped ceilings, drop nipples shall be cut such that sprinkler ceiling plates or escutcheons are of a uniform depth throughout the finished space. The outlet of the reducing coupling shall not extend more than 1 inch below the underside of the ceiling. On pendent sprinklers installed below suspended or dropped ceilings, the distance from the sprinkler deflector to the underside of the ceiling shall not exceed 4 inches. Recessed pendent sprinklers shall be installed such that the distance from the sprinkler deflector to the underside of the ceiling shall not exceed the manufacturer's listed range and shall be of uniform depth throughout the finished area. Pendent sprinklers in suspended ceilings shall be centered in ceiling tile.

3.4.4 Upright Sprinklers

Riser nipples or "sprigs" to upright sprinklers shall contain no fittings between the branch line tee and the reducing coupling at the sprinkler. Riser nipples exceeding 30 inches in length shall be individually supported.

3.4.5 Pipe Joints

Pipe joints shall conform to NFPA 13, except as modified herein. Not more than four threads shall show after joint is made up. Welded joints will be permitted, only if welding operations are performed as required by NFPA 13 at the Contractor's fabrication shop, not at the project construction site. Flanged joints shall be provided where indicated or required by NFPA 13. Grooved pipe and fittings shall be prepared in accordance with the manufacturer's latest published specification according to pipe material, wall thickness and size. Grooved couplings, fittings and grooving tools shall be products of the same manufacturer. For copper tubing, pipe and groove dimensions shall comply with the tolerances specified by the coupling manufacturer. The diameter of grooves made in the field shall be measured using a "go/no-go" gauge, vernier or dial caliper, narrow-land micrometer, or other method specifically approved by the coupling manufacturer for the intended application. Groove width and dimension of groove from end of pipe shall be measured and recorded for each change in grooving tool setup to verify compliance with coupling manufacturer's tolerances. Grooved joints shall not be used in concealed locations, such as behind solid walls or ceilings, unless an access panel is shown on the drawings for servicing or adjusting the joint.

3.4.6 Reducers

Reductions in pipe sizes shall be made with one-piece tapered reducing fittings. The use of grooved-end or rubber-gasketed reducing couplings will not be permitted. When standard fittings of the required size are not manufactured, single bushings of the face type will be permitted. Where used, face bushings shall be installed with the outer face flush with the face of the fitting opening being reduced. Bushings shall not be used in elbow fittings, in more than one outlet of a tee, in more than two outlets of a cross, or where the reduction in size is less than 1/2 inch.

3.4.7 Pipe Penetrations

Cutting structural members for passage of pipes or for pipe-hanger fastenings will not be permitted. Pipes that must penetrate concrete or masonry walls or concrete floors shall be core-drilled and provided with pipe sleeves. Each sleeve shall be Schedule 40 galvanized steel, ductile iron or cast iron pipe and shall extend through its respective wall or floor and be cut flush with each wall surface. Sleeves shall provide required clearance between the pipe and the sleeve per NFPA 13. The space between the sleeve and the pipe shall be firmly packed with mineral wool insulation. Where pipes penetrate fire walls, fire partitions, or floors, pipes shall be fire stopped in accordance with Section 07 84 00 FIRESTOPPING. In penetrations that are not fire-rated or not a floor penetration, the space between the sleeve and the pipe shall be sealed at both ends with plastic waterproof cement that will dry to a firm but pliable mass or with a mechanically adjustable segmented elastomer seal.

3.4.8 Escutcheons

Escutcheons shall be provided for pipe penetration of ceilings and walls. Escutcheons shall be securely fastened to the pipe at surfaces through which piping passes.

3.4.9 Inspector's Test Connection

Unless otherwise indicated, test connection shall consist of 1 inch pipe connected at the riser as a combination test and drain valve; a test valve located approximately 7 feet above the floor; a smooth bore brass outlet equivalent to the smallest orifice sprinkler used in the system; and a painted metal identification sign affixed to the valve with the words "Inspector's Test." The discharge orifice shall be located outside the building wall directed so as not to cause damage to adjacent construction or landscaping during full flow discharge.

3.4.10 Drains

Main drain piping shall be provided to discharge at a safe point outside the building. Auxiliary drains shall be provided as required by NFPA 13.

3.4.11 Installation of Fire Department Connection

Connection shall be pedestal mounted approximately 3 feet above finished grade adjacent to and on the sprinkler system side of the backflow preventer. The piping between the connection and the check valve shall be provided with an automatic drip in accordance with NFPA 13 and arranged to drain to the outside.

3.4.12 Identification Signs

Signs shall be affixed to each control valve, inspector test valve, main drain, auxiliary drain, test valve, and similar valves as appropriate or as required by NFPA 13. Hydraulic design data nameplates shall be permanently affixed to each sprinkler riser as specified in NFPA 13.

3.5 UNDERGROUND PIPING INSTALLATION

The fire protection water main shall be laid, and joints anchored, in accordance with NFPA 24. Minimum depth of cover shall be 3 feet. The supply line shall terminate inside the building with a flanged piece, the bottom of which shall be set not less than 6 inches above the finished floor. A blind flange shall be installed temporarily on top of the flanged piece to prevent the entrance of foreign matter into the supply line. A concrete thrust block shall be provided at the elbow where the pipe turns up toward the floor. In addition, joints shall be anchored in accordance with NFPA 24 using pipe clamps and steel rods from the elbow to the flange above the floor and from the elbow to a pipe clamp in the horizontal run of pipe. Buried steel components shall be provided with a corrosion protective coating in accordance with AWWA C203. Piping more than 5 feet outside the building walls shall meet the requirements of ~~Section 33 12 16.17 WATER UTILITY DISTRIBUTION PIPING~~the American Water specifications attached within Appendix 4 of the project specifications.

3.6 ELECTRICAL WORK

Except as modified herein, electric equipment and wiring shall be in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Alarm

signal wiring connected to the building fire alarm control system shall be in accordance with Section 28 31 76 INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM. Wiring color code shall remain uniform throughout the system.

3.7 PIPE COLOR CODE MARKING

Color code mark piping as specified in Section 09 90 00 PAINTS AND COATINGS.

3.8 PRELIMINARY TESTS

The system, including the underground water mains, and the aboveground piping and system components, shall be tested to assure that equipment and components function as intended. Submit proposed procedures for Preliminary Tests, no later than 14 days prior to the proposed start of the tests and proposed date and time to begin the preliminary tests. The underground and aboveground interior piping systems and attached appurtenances subjected to system working pressure shall be tested in accordance with NFPA 13 and NFPA 24. Upon completion of specified tests, submit 3 copies of the completed Preliminary Test Report, no later than 7 days after the completion of the Tests. The Report shall include both the Contractor's Material and Test Certificate for Underground Piping and the Contractor's Material and Test Certificate for Aboveground Piping. All items in the Preliminary Tests Report shall be signed by the Fire Protection Specialist.

3.8.1 Underground Piping

3.8.1.1 Flushing

Underground piping shall be flushed in accordance with NFPA 24. This includes the requirement to flush the lead-in connection to the fire protection system at a flow rate not less that the calculated maximum water demand rate of the system.

3.8.1.2 Hydrostatic Testing

New underground piping shall be hydrostatically tested in accordance with NFPA 24. The allowable leakage shall be measured at the specified test pressure by pumping from a calibrated container. The amount of leakage at the joints shall not exceed 2 quarts per hour per 100 gaskets or joints, regardless of pipe diameter.

3.8.2 Aboveground Piping

3.8.2.1 Hydrostatic Testing

Aboveground piping shall be hydrostatically tested in accordance with NFPA 13 at not less than 200 psi or 50 psi in excess of maximum system operating pressure and shall maintain that pressure without loss for 2 hours. There shall be no drop in gauge pressure or visible leakage when the system is subjected to the hydrostatic test. The test pressure shall be read from a gauge located at the low elevation point of the system or portion being tested.

3.8.2.2 Backflow Prevention Assembly Forward Flow Test

Each backflow prevention assembly shall be tested at system flow demand,

including all applicable hose streams, as specified in NFPA 13. Provide all equipment and instruments necessary to conduct a complete forward flow test, including 2.5 inch diameter hoses, playpipe nozzles, calibrated pressure gauges, pitot tube gauge, plus all necessary supports to safely secure hoses and nozzles during the test. At the system demand flow, the pressure readings and pressure drop (friction) across the assembly shall be recorded. Provide a metal placard on the backflow prevention assembly that lists the pressure readings both upstream and downstream of the assembly, total pressure drop, and the system test flow rate. The pressure drop shall be compared to the manufacturer's data.

3.8.3 Testing of Alarm Devices

Each alarm switch shall be tested by flowing water through the inspector's test connection. Each water-operated alarm devices shall be tested to verify proper operation.

3.8.4 Main Drain Flow Test

Following flushing of the underground piping, a main drain test shall be made to verify the adequacy of the water supply. Static and residual pressures shall be recorded on the certificate specified in paragraph SUBMITTALS. In addition, a main drain test shall be conducted each time after a main control valve is shut and opened.

3.9 FINAL ACCEPTANCE TEST

Begin the Final Acceptance Test only when the Preliminary Test Report has been approved. Submit proposed procedures for Final Acceptance Test, no later than 14 days prior to the proposed start of the tests, and proposed date and time to begin the Test, submitted with the procedures. Notification shall be provided at least 14 days prior to the proposed start of the test. Notification shall include a copy of the Contractor's Material & Test Certificates. The Fire Protection Specialist shall conduct the Final Acceptance Test and shall provide a complete demonstration of the operation of the system. This shall include operation of control valves and flowing of inspector's test connections to verify operation of associated waterflow alarm switches. After operation of control valves has been completed, the main drain test shall be repeated to assure that control valves are in the open position. Submit as-built shop drawings, at least 14 days after completion of the Final Tests, updated to reflect as-built conditions after all related work is completed. Drawings shall be on reproducible full-size mylar film. In addition, the representative shall have available copies of as-built drawings and certificates of tests previously conducted. The installation shall not be considered accepted until identified discrepancies have been corrected and test documentation is properly completed and received. Submit 3 copies of the completed Final Acceptance Test Report no later than 7 days after the completion of the Final Acceptance Tests. All items in the Final Acceptance Report shall be signed by the Fire Protection Specialist.as specified.

3.10 ONSITE TRAINING

The Fire Protection Specialist shall conduct a training course for operating and maintenance personnel as designated by the Contracting Officer. Submit proposed schedule, at least 14 days prior to the start of related training. Training shall be provided for a period of 8 hours of normal working time broken into four, 2-hour training sessions and shall

start after the system is functionally complete and after final acceptance test. The 2-hour training sessions shall be separated by approximately one-week intervals. Submit 6 Operating and Maintenance Manuals listing step-by-step procedures required for system startup, operation, shutdown, and routine maintenance, at least 14 days prior to field training. The manuals shall include the manufacturer's name, model number, parts list, list of parts and tools that should be kept in stock by the Government for routine maintenance including the name of a local supplier, simplified wiring and controls diagrams, troubleshooting guide, and recommended service organization (including address and telephone number) for each item of equipment. Each service organization submitted shall be capable of providing 4 hour on-site response to a service call on an emergency basis. The Onsite Training shall cover all of the items contained in the approved manuals.

-- End of Section --

SECTION 21 30 00

FIRE PUMPS
04/08

PART 1 GENERAL

1.1 SUMMARY

Except as modified in this Section or on the drawings, install fire pumps in conformance with NFPA 20, NFPA 70, and NFPA 72. In the event of a conflict between specific provisions of this specification and applicable NFPA standards, this specification governs. Devices and equipment for fire protection service must be UL Fire Prot Dir listed or FM APP GUIDE approved. Interpret all reference to the authority having jurisdiction to mean the Contracting Officer.

1.2 SEQUENCING

1.2.1 Primary Fire Pump

Primary fire pump shall automatically operate when the pressure drops to 110 psi. The fire pump shall automatically stop operating when the system pressure reaches 125 psi and after the fire pump has operated for the minimum pump run time specified herein.

1.2.2 Pressure Maintenance Pump

Pressure maintenance pump shall operate when the system pressure drops to 115 psi. Pump shall automatically stop when the system pressure reaches 125 psi and after the pump has operated for the minimum pump run time specified herein.

1.3 FIRE PUMP INSTALLATION RELATED SUBMITTALS

The Fire Protection Specialist shall prepare a list of the submittals, from the Contract Submittal Register, that relate to the successful installation of the fire pump(s), no later than 7 days after the approval of the Fire Protection Specialist and the Manufacturer's Representative. The submittals identified on this list shall be accompanied by a letter of approval signed and dated by the Fire Protection Specialist when submitted to the Government.

1.4 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.3	(2016) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.5	(2017) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard

ASME B16.26	(2018) Standard for Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B16.39	(2020) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300
ASME B31.1	(2020) Power Piping

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA 10084	(2017) Standard Methods for the Examination of Water and Wastewater
AWWA B300	(2010; Addenda 2011) Hypochlorites
AWWA B301	(2010) Liquid Chlorine
AWWA C110/A21.10	(2012) Ductile-Iron and Gray-Iron Fittings for Water
AWWA C111/A21.11	(2017) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C500	(2009) Metal-Seated Gate Valves for Water Supply Service

ASTM INTERNATIONAL (ASTM)

ASTM A47/A47M	(1999; R 2018; E 2018) Standard Specification for Ferritic Malleable Iron Castings
ASTM A53/A53M	(2020) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A183	(2014) Standard Specification for Carbon Steel Track Bolts and Nuts
ASTM A193/A193M	(2020) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A536	(1984; R 2019; E 2019) Standard Specification for Ductile Iron Castings
ASTM A795/A795M	(2013; R 2020) Standard Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use
ASTM B42	(2015a) Standard Specification for Seamless Copper Pipe, Standard Sizes
ASTM B88	(2020) Standard Specification for Seamless Copper Water Tube

ASTM B135/B135M	(2017) Standard Specification for Seamless Brass Tube
ASTM D3308	(2012; R 2017) Standard Specification for PTFE Resin Skived Tape
ASTM F436	(2011) Hardened Steel Washers

FM GLOBAL (FM)

FM APP GUIDE	(updated on-line) Approval Guide http://www.approvalguide.com/

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2018) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 20	(2016; Errata 1 2016; Errata 2 2018) Standard for the Installation of Stationary Pumps for Fire Protection
NFPA 24	(2016; ERTA 2016) Standard for the Installation of Private Fire Service Mains and Their Appurtenances
NFPA 70	(2020; ERTA 20-1 2020; ERTA 20-2 2020; TIA 20-1; TIA 20-2; TIA 20-3; TIA 20-4) National Electrical Code
NFPA 72	(2019; TIA 19-1; ERTA 1 2019) National Fire Alarm and Signaling Code
NFPA 1963	(2019) Standard for Fire Hose Connections

UNDERWRITERS LABORATORIES (UL)

UL 262	(2004; Reprint Oct 2011) Gate Valves for Fire-Protection Service
UL 448	(2017) UL Standard for Safety Centrifugal Stationary Pumps for Fire-Protection Service
UL Fire Prot Dir	(2012) Fire Protection Equipment Directory

1.5 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.

Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submittals with an "AE" are for submittal to the Designer of Record. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Fire Pump Installation Related Submittals

Fire Protection Specialist; G, AE

No later than 14 days after the Notice to Proceed and prior to the submittal of the fire pump installation drawings

SD-02 Shop Drawings

Installation Drawings; G, AE

3 copies

As-Built Drawings; G, AE

Piping Layout; G, AE

Pump House; G, AE

SD-03 Product Data

Catalog Data; G, AE

Spare Parts

Preliminary Tests

At least 14 days prior to the proposed date and time to begin Preliminary Tests

Field Tests; G, AE

At least 2 weeks before starting field tests

Manufacturer's Representative; G, AE

Field Training; G, AE

Army Final Acceptance Test

SD-06 Test Reports

Preliminary Tests

3 copies of the completed Preliminary Tests Reports, no later that 7 days after the completion of the Preliminary Tests.

Army Final Acceptance Test

SD-07 Certificates

Fire Protection Specialist

No later than 14 days after the Notice to Proceed and prior to the submittal of the fire pump installation drawings

Qualifications of Welders

Qualifications of Installer

Preliminary Test Certification

Final Test Certification

SD-10 Operation and Maintenance Data

Operating and Maintenance Instructions; G, AE

At least 14 days prior to conducting field training

Flow Meter

Submit Data Package 2 for flow meter and controllers in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

1.6 EXTRA MATERIALS

Submit Spare Parts data for each different item of equipment and material specified. The data shall include a complete list of parts and supplies, with current unit prices and source of supply, and a list of parts recommended by the manufacturer to be replaced after 1 year and 3 years of service. Include a list of special tools and test equipment required for maintenance and testing of the products supplied by the Contractor.

1.7 QUALITY ASSURANCE

1.7.1 Fire Protection Specialist

Fire Protection Specialist shall coordinate the fire pump electrical requirements with the electrical contractor. Work specified in this section shall be performed under the supervision of and certified by the Fire Protection Specialist. Submit the name and documentation of certification of the proposed Fire Protection Specialists. The Fire Protection Specialist shall be an individual who is a registered professional engineer and a Full Member of the Society of Fire Protection Engineers. The Fire Protection Specialist shall be regularly engaged in the design and installation of the type and complexity of system specified in the Contract documents, and shall have served in a similar capacity for at least three systems that have performed in the manner intended for a period of not less than 6 months.

1.7.2 Qualifications of Welders

Submit certificates of each welder's qualifications prior to site welding; certifications shall not be more than one year old.

1.7.3 Qualifications of Installer

Prior to installation, submit data for approval showing that the Contractor has successfully installed fire pumps and associated equipment of the same type and design as specified herein, or that he has a firm contractual agreement with a subcontractor having such required experience. The data shall include the names and locations of at least two installations where the Contractor, or the subcontractor referred to above, has installed such systems. Indicate the type and design of each system and certify that each system has performed satisfactorily in the

manner intended for a period of not less than 18 months.

1.7.4 Preliminary Test Certification

When preliminary tests have been completed and corrections made, submit a signed and dated certificate with a request for a formal inspection and tests.

1.7.5 Final Test Certification

Concurrent with the Final Acceptance Test Report, submit certification by the Fire Protection Specialist that the fire pump installation is in accordance with the contract requirements, including signed approval of the Preliminary and Final Acceptance Test Reports. Submit data for approval showing the name and certification of all involved individuals with such qualifications at or prior to submittal of drawings.

1.7.6 Manufacturer's Representative

Work specified in this section shall be performed under the supervision of and certified by a representative of the fire pump manufacturer. Submit the name and documentation of certification of the proposed Manufacturer's Representative, concurrent with submittal of the Fire Protection Specialist Qualifications. The Manufacturer's Representative shall be regularly engaged in the installation of the type and complexity of fire pump(s) specified in the Contract documents, and shall have served in a similar capacity for at least three systems that have performed in the manner intended for a period of not less than 6 months.

1.8 DELIVERY, STORAGE, AND HANDLING

Protect all equipment delivered and placed in storage from the weather, excessive humidity and temperature variations, dirt and dust, or other contaminants. Additionally, all pipes shall be either capped or plugged until installed.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

a. Materials and equipment shall be standard products of a manufacturer regularly engaged in the manufacture of such products and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening.

b. Submit manufacturer's catalog data included with the Fire Pump Installation Drawings for each separate piece of equipment proposed for use in the system. Catalog data shall indicate the name of the manufacturer of each item of equipment, with data annotated to indicate model to be provided. In addition, a complete equipment list that includes equipment description, model number and quantity shall be provided. Catalog data for material and equipment shall include, but not be limited to, the following:

(1) Fire pumps, drivers and controllers including manufacturer's certified shop test characteristic curve for each pump. Shop test curve may be submitted after approval of catalog data but shall be submitted prior to the final tests.

(2) Pressure maintenance pump and controller.

(3) Piping components.

(4) Valves, including gate, check, globe and relief valves.

(5) Gauges.

(6) Hose valve manifold test header and hose valves.

(7) Flow meter.

(8) Restrictive orifice union.

(9) Associated devices and equipment.

c. All equipment shall have a nameplate that identifies the manufacturer's name, address, type or style, model or serial number, contract number and accepted date; capacity or size; system in which installed and system which it controls and catalog number. Pumps and motors shall have standard nameplates securely affixed in a conspicuous place and easy to read. Fire pump shall have nameplates and markings in accordance with UL 448. Electric motor nameplates shall provide the minimum information required by NFPA 70, Section 430-7.

2.2 FIRE PUMP

Fire pump shall be electric motor driven, skid-mounted and located in remote pump house. Each pump capacity shall be rated at 750 gpm with a rated net pressure of 75 psi. Fire pump shall furnish not less than 150 percent of rated flow capacity at not less than 65 percent of rated net pressure. Pump shall be centrifugal horizontal split case fire pump. Horizontal pump shall be equipped with automatic air release devices. The maximum rated pump speed shall be 2100 rpm when driving the pump at rated capacity. Pump shall be automatic start and manual stop. Pump shall conform to the requirements of UL 448. Fire pump discharge and suction gauges shall be oil-filled type.

2.3 REQUIREMENTS FOR FIRE PROTECTION SERVICE

2.3.1 General Requirements

Materials and Equipment shall have been tested by Underwriters Laboratories, Inc. and listed in UL Fire Prot Dir or approved by Factory Mutual and listed in FM APP GUIDE. Where the terms "listed" or "approved" appear in this specification, such shall mean listed in UL Fire Prot Dir or FM APP GUIDE.

2.3.2 Alarms

Provide audible and visual alarms as required by NFPA 20 on the controller. Provide remote supervision as required by NFPA 20, in accordance with NFPA 72 under Section 28 31 76 INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM. Provide remote alarm devices located as indicated. Alarm signal shall be activated upon the following conditions: electric motor controller has operated into a pump running condition, loss of electrical power to electric motor starter, and phase reversal on line side of motor starter. Exterior alarm devices shall be

weatherproof type. Provide alarm silencing switch and red signal lamp, with signal lamp arranged to come on when switch is placed in OFF position.

2.4 UNDERGROUND PIPING COMPONENTS

2.4.1 Pipe and Fittings

Provide outside-coated, cement mortar-lined, ductile-iron pipe (with a rated working pressure of 175 psi) conforming to NFPA 24 for piping under the building and less than 5 feet outside of the building walls. Anchor the joints in accordance with NFPA 24; provide concrete thrust block at the elbow where the pipe turns up toward the floor, and restrain the pipe riser with steel rods from the elbow to the flange above the floor. Minimum pipe size shall be 6 inches. Minimum depth of cover shall be as required by NFPA 24, but no less than 3 feet. Piping more than 5 feet outside of the building walls shall be provided under ~~Section 33 12 16.17 WATER UTILITY DISTRIBUTION PIPING~~the American Water specifications attached within Appendix 4 of the project specifications.

2.4.2 Fittings and Gaskets

Fittings shall be ductile iron conforming to AWWA C110/A21.10. Gaskets shall be suitable in design and size for the pipe with which such gaskets are to be used. Gaskets for ductile iron pipe joints shall conform to AWWA C111/A21.11.

2.4.3 Valves and Valve Boxes

Valves shall be gate valves conforming to AWWA C500 or UL 262. Valves shall have cast-iron body and bronze trim. Valve shall open by counterclockwise rotation. Except for post indicator valves, all underground valves shall be provided with an adjustable cast-iron or ductile iron valve box of a size suitable for the valve on which the box is to be used, but not less than 5.25 inches in diameter. The box shall be coated with bituminous coating. A cast-iron or ductile-iron cover with the word "WATER" cast on the cover shall be provided for each box.

2.4.4 Gate Valve and Indicator Posts

Gate valves for underground installation shall be of the inside screw type with counterclockwise rotation to open. Where indicating type valves are shown or required, indicating valves shall be gate valves with an approved indicator post of a length to permit the top of the post to be located 3 feet above finished grade. Gate valves and indicator posts shall be provided with one coat of primer and two coats of red enamel paint and shall be listed in UL Fire Prot Dir or FM APP GUIDE.

2.4.5 Buried Utility Warning and Identification Tape

Detectable aluminum foil plastic-backed tape or detectable magnetic plastic tape manufactured specifically for warning and identification of buried piping shall be provided for all buried piping. Tape shall be detectable by an electronic detection instrument. Tape shall be provided in rolls, 3 inches minimum width, color-coded for the utility involved and imprinted in bold black letters continuously and repeatedly over the entire tape length. Warning and identification shall be "CAUTION BURIED WATER PIPING BELOW" or similar wording. Code and lettering shall be permanent and unaffected by moisture and other substances contained in the trench backfill material. Tape shall be buried at a depth of 12 inches

below the top surface of earth or the top surface of the subgrade under pavement.

2.5 ABOVEGROUND PIPING COMPONENTS

2.5.1 Pipe Sizes 2.5 inches and Larger

2.5.1.1 Pipe

Piping shall be ASTM A53/A53M, Weight Class STD (Standard), Schedule 40 (except for Schedule 30 for pipe sizes 8 inchesand greater in diameter), Type E or Type S, Grade A; black steel pipe. Steel pipe shall be joined by means of flanges welded to the pipe or mechanical grooved joints only. Piping shall not be jointed by welding or weld fittings. Suction piping shall be galvanized on the inside in accordance with NFPA 20.

2.5.1.2 Grooved Mechanical Joints and Fittings

Joints and fittings shall be designed for not less than 175 psi service and shall be the product of the same manufacturer. Fitting and coupling houses shall be malleable iron conforming to ASTM A47/A47M, Grade 32510; ductile iron conforming to ASTM A536, Grade 65-45-12. Gasket shall be the flush type that fills the entire cavity between the fitting and the pipe. Nuts and bolts shall be heat-treated steel conforming to ASTM A183 and shall be cadmium plated or zinc electroplated.

2.5.1.3 Flanges

Flanges shall be ASME B16.5, Class 150 flanges. Flanges shall be provided at valves, connections to equipment, and where indicated.

2.5.1.4 Gaskets

Gaskets shall be AWWA C111/A21.11, cloth inserted red rubber gaskets.

2.5.1.5 Bolts

Bolts shall be ASTM A193/A193M, Grade B7. Bolts shall extend no less than three full threads beyond the nut with bolts tightened to the required torque.

2.5.1.6 Nuts

Nuts shall be ASTM A193/A193M, Grade 5.

2.5.1.7 Washers

Washers shall meet the requirements of ASTM F436. Flat circular washers shall be provided under all bolt heads and nuts.

2.5.2 Piping Sizes 2 inches and Smaller

2.5.2.1 Steel Pipe

Steel piping shall be ASTM A795/A795M, Weight Class STD (Standard), Schedule 40, Type E or Type S, Grade A, zinc-coated steel pipe with threaded end connections. Fittings shall be ASME B16.3, Class 150, zinc-coated threaded fittings. Unions shall be ASME B16.39, Class 150, zinc-coated unions.

2.5.2.2 Copper Tubing

Copper tubing shall be ASTM B88, Type L or K, soft annealed. Fittings shall be ASME B16.26, flared joint fittings. Pipe nipples shall be ASTM B42 copper pipe with threaded end connections.

2.5.3 Pipe Hangers and Supports

Pipe hangers and support shall be UL listed UL Fire Prot Dir or FM approved FM APP GUIDE and shall be the adjustable type. Finish of rods, nuts, washers, hangers, and supports shall be zinc-plated after fabrication.

2.5.4 Valves

Valves shall be UL listed UL Fire Prot Dir or FM approved FM APP GUIDE for fire protection service. Valves shall have flange or threaded end connections.

2.5.4.1 Gate Valves and Control Valves

Gate valves and control valves shall be outside screw and yoke (O.S.&Y.) type which open by counterclockwise rotation. Butterfly-type control valves are not permitted.

2.5.4.2 Tamper Switch

The suction control valves, the discharge control valves, valves to test header and flow meter, and the by-pass control valves shall be equipped with valve tamper switches for monitoring by the fire alarm system.

2.5.4.3 Check Valve

Check valve shall be clear open, swing type check valve with flange or threaded inspection plate.

2.5.4.4 Relief Valve

Relief valve shall be pilot operated or type conforming to NFPA 20. A means of detecting water motion in the relief lines shall be provided where the discharge is not visible within the pump house.

2.5.4.5 Circulating Relief Valve

An adjustable circulating relief valve shall be provided for each fire pump in accordance with NFPA 20.

2.5.4.6 Suction Pressure Regulating Valve

Suction pressure regulating valve shall be FM approved FM APP GUIDE. Suction pressure shall be monitored through a pressure line to the controlling mechanism of the regulating valve. Valve shall be arranged in accordance with the manufacturer's recommendations.

2.5.5 Hose Valve Manifold Test Header

Construct header of steel pipe. Provide ASME B16.5, Class 150 flanged inlet connection to hose valve manifold assembly. Provide approved bronze

hose gate valve with 2.5 inch National Standard male hose threads with cap and chain; locate 3 feet above grade in the horizontal position for each test header outlet. Welding shall be metallic arc process in accordance with ASME B31.1.

2.5.6 Pipe Sleeves

A pipe sleeve shall be provided at each location where piping passes entirely through walls, ceilings, roofs, and floors, including pipe entering buildings from the exterior. Secure sleeves in position and location during construction. Provide sleeves of sufficient length to pass through entire thickness of walls, ceilings, and floors. Provide one inch minimum clearance between exterior of piping or pipe insulation, and interior of sleeve or core-drilled hole. Firmly pack space with mineral wool insulation. Seal space at both ends of the sleeve or core-drilled hole with plastic waterproof cement which will dry to a firm but pliable mass, or provide a mechanically adjustable segmented elastomeric seal. In fire walls and fire floors, a fire seal shall be provided between the pipe and the sleeve in accordance with Section 07 84 00 FIRESTOPPING.

a. Sleeves in Masonry and Concrete Walls, Ceilings, Roofs, and Floors: Provide hot-dip galvanized steel, ductile-iron, or cast-iron pipe sleeves. Core drilling of masonry and concrete may be provided in lieu of pipe sleeves provided that cavities in the core-drilled hole be completely grouted smooth.

b. Sleeves in Other Than Masonry and Concrete Walls, Ceilings, Roofs, and Floors: Provide galvanized steel sheet pipe not less than 0.90 psf.

2.5.7 Escutcheon Plates

Provide one-piece or split-hinge metal plates for piping entering floors, walls, and ceilings in exposed areas. Provide polished stainless steel or chromium-plated finish on copper alloy plates in finished spaces. Provide paint finish on plates in unfinished spaces. Plates shall be secured in place.

2.6 DISINFECTING MATERIALS

2.6.1 Liquid Chlorine

Liquid chlorine shall conform to AWWA B301.

2.6.2 Hypochlorites

Calcium hypochlorite and sodium hypochlorite shall conform to AWWA B300.

2.7 ELECTRIC MOTOR DRIVER

Motors, controllers, contactors, and disconnects shall be provided with their respective pieces of equipment, as specified herein and shall have electrical connections provided under Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Controllers and contactors shall have a maximum of 120-volt control circuits, and auxiliary contacts for use with the controls furnished. When motors and equipment furnished are larger than sizes indicated, the cost of providing additional electrical service and related work shall be included under this section. Motor shall conform to NEMA MG 1 Design B type. Integral size motors shall be the premium efficiency type in accordance with NEMA MG 1. Motor horsepower shall be

of sufficient size so that the nameplate horsepower rating will not be exceeded throughout the entire published pump characteristic curve. The motor and fire pump controller shall be fully compatible.

2.8 FIRE PUMP CONTROLLER

Controller shall be the automatic type and UL listed UL Fire Prot Dir or FM approved FM APP GUIDE for fire pump service. Pump shall be arranged for automatic start and stop, and manual push-button stop. Automatic stopping shall be accomplished only after all starting causes have returned to normal and after a minimum pump run time has elapsed. Controllers shall be completely terminally wired, ready for field connections, and mounted in a NEMA Type 2 drip-proof enclosure arranged so that controller current carrying parts will not be less than 12 inches above the floor. Controller shall be provided with voltage surge arresters installed in accordance with NFPA 20. Controller shall be equipped with a bourdon tube pressure switch or a solid state pressure switch with independent high and low adjustments, automatic starting relay actuated from normally closed contacts, visual alarm lamps and supervisory power light. Controller shall be equipped with a thermostat switch with adjustable setting to monitor the pump room temperature and to provide an alarm when temperatures falls below 40 degrees F. The controller shall be factory-equipped with a heater operated by thermostat to prevent moisture in the cabinet.

2.8.1 Controller for Electric Motor Driven Fire Pump

Controller shall be electronic soft start starting type. Controller shall be designed as indicated. Controller and transfer switch shall have a short circuit rating as indicated. An automatic transfer switch (ATS) shall be provided for each fire pump. The ATS shall comply with NFPA 20 and shall be specifically listed for fire pump service. The ATS shall transfer source of power to the alternate source upon loss of normal power. Controller shall monitor pump running, loss of a phase or line power, phase reversal and pump room temperature. Alarms shall be individually displayed in front of panel by lighting of visual lamps. Each lamp shall be labeled with rigid etched plastic labels. Controller shall be equipped with terminals for remote monitoring of pump running, pump power supply trouble (loss of power or phase and phase reversal), and pump room trouble (pump room temperature, and for remote start. Limited service fire pump controllers are not permitted, except for fire pumps driven by electric motors rated less than 15 hp. Controller shall be equipped with a 7-day electric pressure recorder with 24-hour spring wound back-up. The pressure recorder shall provide a readout of the system pressure from 0 to 15 hp, time, and date. Controller shall require the pumps to run for ten minutes for pumps with driver motors under 200 horsepower and for 15 minutes for pumps with motors 200 horsepower and greater, prior to automatic shutdown. The controller shall be equipped with an externally operable isolating switch which manually operates the motor circuit. Means shall be provided in the controller for measuring current for all motor circuit conductors. Time delay before transfer to emergency power shall be adjustable and factory set at 0 minutes.

2.9 PRESSURE SENSING LINE

A completely separate pressure sensing line shall be provided for each fire pump and for the jockey pump. The sensing line shall be arranged in accordance with Figure A-7-5.2.1. of NFPA 20. The sensing line shall be 1/2 inchH58 brass tubing complying with ASTM B135/B135M. The sensing line

shall be equipped with two restrictive orifice unions each. Restricted orifice unions shall be ground-face unions with brass restricted diaphragms drilled for a 3/32 inch. Restricted orifice unions shall be mounted in the horizontal position, not less than 5 feet apart on the sensing line. Two test connections shall be provided for each sensing line. Test connections shall consist of two brass 1/2 inch globe valves and 1/4 inch gauge connection tee arranged in accordance with NFPA 20. One of the test connections shall be equipped with a 0 to 300 psi water oil-filled gauge. Sensing line shall be connected to the pump discharge piping between the discharge piping control valve and the check valve.

2.10 PRESSURE MAINTENANCE PUMP

2.10.1 General

Pressure maintenance pump shall be electric motor driven, in-line vertical shaft, centrifugal type with a rated discharge of 7.5 gpm at 83 psig. Pump shall draft from the suction supply side of the suction pipe gate valve of the fire pump and shall discharge into the system at the downstream side of the pump discharge gate valve. An approved indicating gate valve of the outside screw and yoke (O.S.&Y.) type shall be provided in the maintenance pump discharge and suction piping. Oil-filled water pressure gauge and approved check valve in the maintenance pump discharge piping shall be provided. Check valve shall be swing type with removable inspection plate.

2.10.2 Pressure Maintenance Pump Controller

Pressure maintenance pump controller shall be arranged for automatic and manual starting and stopping and equipped with a "manual-off-automatic" switch. The controller shall be completely prewired, ready for field connections, and wall-mounted in a NEMA Type 2 drip-proof enclosure. The controller shall be equipped with a bourdon tube pressure switch or a solid state pressure switch with independent high and low adjustments for automatic starting and stopping. A sensing line shall be provided connected to the pressure maintenance pump discharge piping between the control valve and the check valve. The sensing line shall conform to paragraph, PRESSURE SENSING LINE. The sensing line shall be completely separate from the fire pump sensing lines. An adjustable run timer shall be provided to prevent frequent starting and stopping of the pump motor. The run timer shall be set for 2 minutes.

2.11 PUMP BASE PLATE AND PAD

Provide a common base plate for each horizontal-shaft fire pump for mounting pump and driver unit. Construct the base plate of cast iron with raised lip tapped for drainage or welded steel shapes with suitable drainage. Provide each base plate for the horizontal fire pumps with a 1 inchgalvanized steel drain line piped to the nearest floor drain. For vertical shaft pumps, pump head shall be provided with a cast-iron base plate and shall serve as the sole plate for mounting the discharge head assembly. Mount pump units and bases on a raised 6 inchesreinforced concrete pad that is an integral part of the reinforced concrete floor.

2.12 HOSE VALVE MANIFOLD TEST HEADER

Hose valve test header shall be connected by ASME B16.5, Class 150 flange inlet connection. Hose valves shall be UL listed UL Fire Prot Dir or FM approved FM APP GUIDE bronze hose gate valves with 2.5 inches American

National Fire Hose Connection Screw Standard Threads (NH) in accordance with NFPA 1963. The number of valves shall be in accordance with NFPA 20. Each hose valve shall be equipped with a cap and chain, and located no more than 3 feet and no less than 2 feet above grade.

2.13 FLOW METER

Meter shall be UL listed UL Fire Prot Dir or FM approved FM APP GUIDE as flow meters for fire pump installation with direct flow readout device. Flow meter shall be capable of metering any waterflow quantities between 50 percent and 150 percent of the rated flow of the pumps. Arrange piping to permit flow meter to discharge to pump suction and to discharge through test header. The meter throttle valve and the meter control valves shall be O.S.&Y. valves. Provide automatic air release if flow meter piping between pump discharge and pump suction forms an inverted "U". Meter shall be of the venturi type.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing the work.

3.2 INSPECTION BY FIRE PROTECTION SPECIALIST

The Fire Protection Specialist shall periodically perform a thorough inspection of the fire pump installation, including visual observation of the pump while running, to assure that the installation conforms to the contract requirements. There shall be no excessive vibration, leaks (oil or water), unusual noises, overheating, or other potential problems. Inspection shall include piping and equipment clearance, access, supports, and guards. Any discrepancy shall be brought to the attention of the Contracting Officer in writing, no later than three working days after the discrepancy is discovered. The Fire Protection Specialist shall witness the preliminary and final acceptance tests and, after completion of the inspections and a successful final acceptance test, shall sign test results and certify in writing that the installation the fire pump installation is in accordance with the contract requirements.

3.3 INSTALLATION

Equipment, materials, workmanship, fabrication, assembly, erection, installation, examination, inspection and testing shall be in accordance NFPA 20, except as modified herein. In addition, the fire pump and engine shall be installed in accordance with the written instructions of the manufacturer.

3.3.1 Installation Drawings

Submit Fire Pump Installation Drawings consisting of a detailed plan view, detailed elevations and sections of the pump room, equipment and piping, drawn to a scale of not less than 1/2 inch = 1 foot. Drawings shall indicate equipment, piping, and associated pump equipment to scale. Indicate all clearance, such as those between piping and equipment; between equipment and walls, ceiling and floors; and for electrical working distance clearance around all electrical equipment. Include a legend identifying all symbols, nomenclatures, and abbreviations.

Indicate a complete piping and equipment layout including elevations and/or section views of the following:

a. Fire pumps, controllers, piping, valves, and associated equipment.

b. Sensing line for each pump including the pressure maintenance pump.

c. Restraint of underground water main at entry-point to the building including details of pipe clamps, tie rods, mechanical retainer glands, and thrust blocks.

d. A one-line schematic diagram indicating layout and sizes of all piping, devices, valves and fittings.

e. A complete point-to-point connection drawing of the pump power, control and alarm systems, as well as interior wiring schematics of each controller.

3.3.2 Pump House Configuration

Provide detail plan view of the pump house including elevations and sections showing the fire pumps, associated equipment, and piping. Submit working drawings on sheets not smaller than 24 by 36 inches; include data for the proper installation of each system. Show piping schematic of pumps, devices, valves, pipe, and fittings. Provide an isometric drawing of the fire pump and all associated piping. Show point to point electrical wiring diagrams. Show piping layout and sensing piping arrangement. Show engine fuel and cooling system. Include:

a. Pumps, drivers, and controllers

b. Hose valve manifold test header

c. Circuit diagrams for pumps

d. Wiring diagrams of each controller

3.3.3 Accessories

Tank supports, piping offsets, fittings, and any other accessories required shall be furnished as specified to provide a complete installation and to eliminate interference with other construction.

3.4 PIPE AND FITTINGS

Piping shall be inspected, tested and approved before burying, covering, or concealing. Fittings shall be provided for changes in direction of piping and for all connections. Changes in piping sizes shall be made using tapered reducing pipe fittings. Bushings shall not be used.

3.4.1 Cleaning of Piping

Interior and ends of piping shall be clean and free of any water or foreign material. Piping shall be kept clean during installation by means of plugs or other approved methods. When work is not in progress, open ends of the piping shall be securely closed so that no water or foreign matter will enter the pipes or fittings. Piping shall be inspected before placing in position.

3.4.2 Threaded Connections

Jointing compound for pipe threads shall be polytetrafluoroethylene (PTFE) pipe thread tape conforming to ASTM D3308 and shall be applied to male threads only. Exposed ferrous pipe threads shall be provided with one coat of zinc molybdate primer applied to a minimum of dry film thickness of 1 mil.

3.4.3 Pipe Hangers and Supports

Additional hangers and supports shall be provided for concentrated loads in aboveground piping, such as for valves and risers.

3.4.3.1 Vertical Piping

Piping shall be supported at each floor, at not more than 10 foot intervals.

3.4.3.2 Horizontal Piping

Horizontal piping supports shall be spaced as follows:

MAXIMUM SPACING (FEET)										
Nominal Pipe Size (inches)	1 and Under	1.25	1.5	2	2.5	3	3.5	4	5	6+
Copper Tube	6	7	8							
Steel Pipe	7	8	9	10	11	12	13	14	16	17

3.4.4 Underground Piping

Installation of underground piping and fittings shall conform to NFPA 24. Joints shall be anchored in accordance with NFPA 24. Concrete thrust block shall be provided at elbow where pipe turns up towards floor, and the pipe riser shall be restrained with steel rods from the elbow to the flange above the floor. After installation in accordance with NFPA 24, rods and nuts shall be thoroughly cleaned and coated with asphalt or other corrosion-retard material approved by the Contracting Officer. Minimum depth of cover shall be 3 feet.

3.4.5 Grooved Mechanical Joint

Grooves shall be prepared according to the coupling manufacturer's instructions. Grooved fittings, couplings, and grooving tools shall be products of the same manufacturer. Pipe and groove dimensions shall comply with the tolerances specified by the coupling manufacturer. The diameter of grooves made in the field shall be measured using a "go/no-go" gauge, vernier or dial caliper, narrow-land micrometer, or other method specifically approved by the coupling manufacturer for the intended

application. Groove width and dimension of groove from end of pipe shall be measured for each change in grooving tool setup to verify compliance with coupling manufacturer's tolerances. Grooved joints shall not be used in concealed locations, such as behind solid walls or ceilings, unless an access panel is shown on the drawings for servicing or adjusting the joint.

3.5 ELECTRICAL WORK

Electric motor and controls shall be in accordance with NFPA 20, NFPA 72 and NFPA 70, unless more stringent requirements are specified herein or are indicated on the drawings. Electrical wiring and associated equipment shall be provided in accordance with NFPA 20 and Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide wiring in rigid metal conduit or intermediate metal conduit, except electrical metallic tubing conduit may be provided in dry locations not enclosed in concrete or where not subject to mechanical damage.

3.6 PIPE COLOR CODE MARKING

Color code marking of piping as specified in Section 09 90 00 PAINTS AND COATINGS.

3.7 FLUSHING

The fire pump suction and discharge piping shall be flushed at 150 percent of rated capacity of each pump. Where the pump installation consists of more than one pump, the flushing shall be the total quantity of water flowing when all pumps are discharging at 150 percent of their rated capacities. The new pumps may be used to attain the required flushing volume. No underground piping shall be flushed by using the fire pumps. Flushing operations shall continue until water is clear, but not less than 10 minutes. Submit a signed and dated flushing certificate before requesting field testing.

3.8 FIELD TESTS

Submit system diagrams that show the layout of equipment, piping, and storage units, and typed condensed sequence of operation, wiring and control diagrams, and operation manuals explaining preventative maintenance procedures, methods of checking the system for normal, safe operation, and procedures for safely starting and stopping the system shall be framed under glass or laminated plastic. After approval, these items shall be posted where directed.

3.8.1 Hydrostatic Test

Piping shall be hydrostatically tested at 225 psigfor a period of 2-hours, or at least 50 psiin excess of the maximum pressure, when the maximum pressure in the system is in excess of 175 psi in accordance with NFPA 20.

3.8.2 Preliminary Tests

Submit proposed procedures for Preliminary Tests prior to the proposed date and time to begin Preliminary Tests. The Fire Protection Specialist shall take all readings and measurements. The Manufacturer's Representative, a representative of the fire pump controller manufacturer, and a representative of the diesel engine manufacturer (when supplied) shall witness the complete operational testing of the fire pump and drivers. The fire pump controller manufacturer's representative and the

diesel engine manufacturer's representative shall each be an experienced technician employed by the respective manufacturers and capable of demonstrating operation of all features of respective components including trouble alarms and operating features. Fire pumps, drivers and equipment shall be thoroughly inspected and tested to insure that the system is correct, complete, and ready for operation. Tests shall ensure that pumps are operating at rated capacity, pressure and speed. Tests shall include manual starting and running to ensure proper operation and to detect leakage or other abnormal conditions, flow testing, automatic start testing, testing of automatic settings, sequence of operation check, test of required accessories; test of pump alarms devices and supervisory signals, test of pump cooling, operational test of relief valves, and test of automatic power transfer, if provided. Pumps shall run without abnormal noise, vibration or heating. If any component or system was found to be defective, inoperative, or not in compliance with the contract requirements during the tests and inspection, the corrections shall be made and the entire preliminary test shall be repeated. Submit Preliminary Tests Reports, to include both the Contractor's Material and Test Certificate for Underground Piping and the Contractor's Material and Test Certificate for Aboveground Piping. All items in the Report shall be signed by the Fire Protection Specialist and the Manufacturer's Representative.

3.8.3 Army Final Acceptance Test

The Fire Protection Specialist shall take all readings and measurements. The Manufacturer's Representative, the fire pump controller manufacturer's representative, and the diesel engine manufacturer's representative (when supplied) shall also witness for the final tests. Repair any damage caused by hose streams or other aspects of the test. Submit proposed date and time to begin Army Final Acceptance Test, with the Acceptance Procedures. Notification shall be provided at least 14 days prior to the proposed start of the test. Submit 3 copies of the completed Army Final Acceptance Test Reports, no later that 7 days after the completion of the tests. All items in the reports shall be signed by the Fire Protection Specialist and the Manufacturer's Representative. Test reports in booklet form (each copy furnished in a properly labeled three ring binder) showing all field tests and measurements taken during the preliminary and final testing, and documentation that proves compliance with the specified performance criteria, upon completion of the installation and final testing of the installed system. Each test report shall indicate the final position of the controls and pressure switches. The test reports shall include the description of the hydrostatic test conducted on the piping and flushing of the suction and discharge piping. A copy of the manufacturer's certified pump curve for each fire pump shall be included in the report. Notification shall include a copy of the Contractor's Material & Test Certificates. Include the following in the final acceptance test:

3.8.3.1 Flow Tests

Flow tests using the test header, hoses and playpipe nozzles shall be conducted. Flow tests shall be performed at churn (no flow), 75, 100, 125 and 150 percent capacity for each pump and at full capacity of the pump installation. Flow readings shall be taken from each nozzle by means of a calibrated pitot tube with gauge or other approved measuring equipment. Rpm, suction pressure and discharge pressure reading shall be taken as part of each flow test. Voltage and ampere readings shall taken on each phase as part of each flow test for electric-motor driven pumps.

3.8.3.2 Starting Tests

Pumps shall be tested for automatic starting and sequential starting. Setting of the pressure switches shall be tested when pumps are operated by pressure drop. Tests may be performed by operating the test connection on the pressure sensing lines. As a minimum, each pump shall be started automatically 10 times and manually 10 times, in accordance with NFPA 20. Tests of engine-driven pumps shall be divided equally between both set of batteries. The fire pumps shall be operated for a period of a least 10 minutes for each of the starts; except that electric motors over 200 horsepowershall be operated for at least 15 minutes and shall not be started more than 2 times in 10 hours. Pressure settings that include automatic starting and stopping of the fire pump(s) shall be indicated on an etched plastic placard, attached to the corresponding pump controller.

3.8.3.3 Alarms

All pump alarms, both local and remote, shall be tested. Supervisory alarms for diesel drivers shall be electrically tested for low oil pressure, high engine jacket coolant temperature, shutdown from overspeed, battery failure and battery charger failure.

3.8.3.4 Miscellaneous

Valve tamper switches shall be tested. Pressure recorder operation relief valve settings, valve operations, operation and accuracy of meters and gauges, and other accessory devices shall be verified.

3.8.3.5 Alternate Power Source

On installations with an alternate source of power and an automatic transfer switch, loss of primary power shall be simulated and transfer shall occur while the pump is operating at peak load. Transfer from normal to emergency source and retransfer from emergency to normal source shall not cause opening of overcurrent devices in either line. At least half of the manual and automatic starting operations listed shall be performed with the fire pump connected to the alternate source.

3.8.3.6 Correction of Deficiencies

If equipment was found to be defective or non-compliant with contract requirements, perform corrective actions and repeat the tests. Tests shall be conducted and repeated if necessary until the system has been demonstrated to comply with all contract requirements.

3.8.3.7 Test Documentation

The Manufacturer's Representative shall supply a copy of the manufacturer's certified curve for each fire pump at the time of the test. The Fire Protection Specialist shall record all test results and plot curve of each pump performance during the test. Complete pump acceptance test data of each fire pump shall be recorded. The pump acceptance test data shall be on forms that give the detail pump information such as that which is indicated in Figure A-11-2.6.3(f) of NFPA 20. All test data records shall be submitted in a three ring binder.

3.8.4 Test Equipment

Provide all equipment and instruments necessary to conduct a complete final test, including 2.5 inch diameter hoses, playpipe nozzles, pitot tube gauges, portable digital tachometer, voltage and ampere meters, and calibrated oil-filled water pressure gauges. Provide all necessary supports to safely secure hoses and nozzles during the test. The Government will furnish water for the tests.

3.9 DISINFECTION

After all system components are installed including pumps, piping, and other associated work, and all hydrostatic tests are successfully completed, thoroughly flush the pumps and all piping to be disinfected with potable water until there is no visible sign of dirt or other residue. and hydrostatic test are successfully completed, each portion of the piping specified in this Section system to be disinfected shall be thoroughly flushed with potable water until all entrained dirt and other foreign materials have been removed before introducing chlorinating material.

3.9.1 Chlorination

The chlorinating material shall be hypochlorites or liquid chlorine. The chlorinating material shall be fed into the sprinkler piping at a constant rate of 50 parts per million (ppm). A properly adjusted hypochlorite solution injected into the system with a hypochlorinator, or liquid chlorine injected into the system through a solution-fed chlorinator and booster pump shall be used. Chlorination application shall continue until the entire system if filled. The water shall remain in the system for a minimum of 24 hours. Each valve in the system shall be opened and closed several times to ensure its proper disinfection. Following the 24-hour period, no less than 25 ppm chlorine residual shall remain in the system.

3.9.2 Flushing

The system shall then be flushed with clean water until the residual chlorine is reduced to less than one part per million. Samples of water in disinfected containers for bacterial examination will be taken from several system locations which are approved by the Contracting Officer.

3.9.3 Sample Testing

Samples shall be tested for total coliform organisms (coliform bacteria, fecal coliform, streptococcal, and other bacteria) in accordance with AWWA 10084. The testing method shall be either the multiple-tube fermentation technique or the membrane-filter technique. The disinfection shall be repeated until tests indicate the absence of coliform organisms (zero mean coliform density per 100 milliliters) in the samples for at least 2 full days. The system will not be accepted until satisfactory bacteriological results have been obtained.

3.10 SYSTEM STARTUP

Fully enclose or properly guard coupling, rotating parts, gears, projecting equipment, etc. so as to prevent possible injury to persons that come in close proximity of the equipment. Conduct testing of the fire pumps in a safe manner and ensure that all equipment is safely secured. Hoses and nozzles used to conduct flow tests shall be in

excellent condition and shall be safely anchored and secured to prevent any misdirection of the hose streams.

Post operating instructions for pumps, drivers, controllers, and flow meters.

3.11 CLOSEOUT ACTIVITIES

3.11.1 Field Training

The Fire Protection Specialist and the Manufacturer's Representative shall conduct a training course for operating and maintenance personnel as designated by the Contracting Officer. Submit the proposed schedule for field training at least 14 days prior to the start of related training. Training shall be provided for a period of four 2-hour sessions of normal working time, separated by approximately one-week intervals, and shall start after the fire pump installation is functionally complete and after the Final Acceptance Test." The field instruction shall cover all of the items contained in the approved Operating and Maintenance Instructions. Submit manuals listing step-by-step procedures required for system startup, operation, shutdown, and routine maintenance. The manuals shall include the manufacturer's name, model number, parts list, list of parts and tools that should be kept in stock by the Government for routine maintenance including the name of a local supplier, simplified wiring and controls diagrams, troubleshooting guide, and recommended service organization (including address and telephone number) for each item of equipment. Data Package 3 shall be submitted for fire pumps and drivers in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA. Each service organization submitted shall be capable of providing 4 hour onsite response to a service call on an emergency basis.

3.11.2 As-Built Drawings

Submit As-Built Drawings, no later than 14 days after completion of the Final Tests. Update he Fire Pump Installation Drawings to reflect as-built conditions after all related work is completed and shall be on reproducible full-size mylar film.

3.12 PROTECTION

Carefully remove materials so as not to damage material which is to remain. Replace existing work damaged by the Contractor's operations with new work of the same construction.

-- End of Section --

SECTION 23 07 00

THERMAL INSULATION FOR MECHANICAL SYSTEMS
02/13

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. At the discretion of the Government, the manufacturer of any material supplied will be required to furnish test reports pertaining to any of the tests necessary to assure compliance with the standard or standards referenced in this specification.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 90.1 - IP	(2013) Energy Standard for Buildings Except Low-Rise Residential Buildings
ASHRAE 90.1 - SI	(2013) Energy Standard for Buildings Except Low-Rise Residential Buildings
ASHRAE 90.2	(2018) Energy-Efficient Design of Low-Rise Residential Buildings

ASTM INTERNATIONAL (ASTM)

ASTM A167	(2011) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A240/A240M	(2018) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A580/A580M	(2018) Standard Specification for Stainless Steel Wire
ASTM B209	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM C195	(2007; R 2013) Standard Specification for Mineral Fiber Thermal Insulating Cement
ASTM C450	(2008) Standard Practice for Fabrication of Thermal Insulating Fitting Covers for NPS Piping, and Vessel Lagging
ASTM C533	(2017) Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation
ASTM C534/C534M	(2016) Standard Specification for

	Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
ASTM C547	(2019) Standard Specification for Mineral Fiber Pipe Insulation
ASTM C552	(2017; E 2018) Standard Specification for Cellular Glass Thermal Insulation
ASTM C591	(2019) Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation
ASTM C610	(2015) Standard Specification for Molded Expanded Perlite Block and Pipe Thermal Insulation
ASTM C647	(2008; R 2013) Properties and Tests of Mastics and Coating Finishes for Thermal Insulation
ASTM C795	(2008; R 2018) Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel
ASTM C916	(2020) Standard Specification for Adhesives for Duct Thermal Insulation
ASTM C920	(2018) Standard Specification for Elastomeric Joint Sealants
ASTM C921	(2010) Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation
ASTM C1126	(2018) Standard Specification for Faced or Unfaced Rigid Cellular Phenolic Thermal Insulation
ASTM C1136	(2017a) Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation
ASTM C1710	(2011) Standard Guide for Installation of Flexible Closed Cell Preformed Insulation in Tube and Sheet Form
ASTM D882	(2012) Tensile Properties of Thin Plastic Sheeting
ASTM D2863	(2017a) Standard Test Method for Measuring the Minimum Oxygen Concentration to Support Candle-Like Combustion of Plastics (Oxygen Index)
ASTM D5590	(2000; R 2010; E 2012) Standard Test Method for Determining the Resistance of Paint Films and Related Coatings to Fungal

	Defacement by Accelerated Four-Week Agar Plate Assay
ASTM E84	(2020) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E90	(2009; R2016) Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements
ASTM E96/E96M	(2016) Standard Test Methods for Water Vapor Transmission of Materials
ASTM E336	(2020) Standard Test Method for Measurement of Airborne Sound Attenuation between Rooms in Buildings
ASTM E2231	(2018) Standard Practice for Specimen Preparation and Mounting of Pipe and Duct Insulation Materials to Assess Surface Burning Characteristics

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)

CDPH SECTION 01350	(2010; Version 1.1) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers

FM GLOBAL (FM)

FM APP GUIDE	(updated on-line) Approval Guide http://www.approvalguide.com/

GREEN SEAL (GS)

GS-36	(2013) Adhesives for Commercial Use

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 2758	(2014) Paper - Determination of Bursting Strength

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation

MIDWEST INSULATION CONTRACTORS ASSOCIATION (MICA)

MICA Insulation Stds	(8th Ed) National Commercial & Industrial Insulation Standards

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 90A	(2018) Standard for the Installation of Air Conditioning and Ventilating Systems
NFPA 90B	(2018) Standard for the Installation of Warm Air Heating and Air Conditioning Systems

SCIENTIFIC CERTIFICATION SYSTEMS (SCS)

SCS	SCS Global Services (SCS) Indoor Advantage

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD)

SCAQMD Rule 1168	(2017) Adhesive and Sealant Applications

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-A-3316	(1987; Rev C; Am 2 1990) Adhesives, Fire-Resistant, Thermal Insulation
MIL-A-24179	(1969; Rev A; Am 2 1980; Notice 1 1987) Adhesive, Flexible Unicellular-Plastic Thermal Insulation
MIL-PRF-19565	(1988; Rev C) Coating Compounds, Thermal Insulation, Fire- and Water-Resistant, Vapor-Barrier

UNDERWRITERS LABORATORIES (UL)

UL 94	(2013; Reprint Sep 2017) UL Standard for Safety Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
UL 723	(2018) UL Standard for Safety Test for Surface Burning Characteristics of Building Materials
UL 2818	(2013) GREENGUARD Certification Program For Chemical Emissions For Building Materials, Finishes And Furnishings

1.2 SYSTEM DESCRIPTION

1.2.1 General

Provide field-applied insulation and accessories on mechanical systems as specified herein; factory-applied insulation is specified under the piping, duct or equipment to be insulated. Field applied insulation materials required for use on Government-furnished items as listed in the SPECIAL CONTRACT REQUIREMENTS shall be furnished and installed by the Contractor.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation;

submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submittals with an "AE" are for submittal to the Designer of Record. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

Submit the three SD types, SD-02 Shop Drawings, SD-03 Product Data, and SD-08 Manufacturer's Instructions at the same time for each system.

SD-02 Shop Drawings

MICA Plates; G, RO

Pipe Insulation Systems and Associated Accessories

Duct Insulation Systems and Associated Accessories

Equipment Insulation Systems and Associated Accessories

Recycled content for insulation materials; S

SD-03 Product Data

Pipe Insulation Systems; G, AE

Duct Insulation Systems; G, AE

Equipment Insulation Systems; G, AE

SD-04 Samples

Thermal Insulation; G, AE

Display Samples; G, AE

SD-07 Certificates

Indoor air quality for adhesives; S

SD-08 Manufacturer's Instructions

Pipe Insulation Systems; G, AE

Duct Insulation Systems; G, AE

Equipment Insulation Systems; G, AE

1.4 CERTIFICATIONS

1.4.1 Adhesives and Sealants

Provide products certified to meet indoor air quality requirements by UL 2818 (Greenguard) Gold, SCS Global Services Indoor Advantage Gold or provide certification or validation by other third-party programs that products meet the requirements of this Section. Provide current product certification documentation from certification body. When product does not have certification, provide validation that product meets the indoor air

quality product requirements cited herein.

1.5 QUALITY ASSURANCE

1.5.1 Installer Qualification

Qualified installers shall have successfully completed three or more similar type jobs within the last 5 years.

1.6 DELIVERY, STORAGE, AND HANDLING

Materials shall be delivered in the manufacturer's unopened containers. Materials delivered and placed in storage shall be provided with protection from weather, humidity, dirt, dust and other contaminants. The Contracting Officer may reject insulation material and supplies that become dirty, dusty, wet, or contaminated by some other means. Packages or standard containers of insulation, jacket material, cements, adhesives, and coatings delivered for use, and samples required for approval shall have manufacturer's stamp or label attached giving the name of the manufacturer and brand, and a description of the material, date codes, and approximate shelf life (if applicable). Insulation packages and containers shall be asbestos free.

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS

Provide materials which are the standard products of manufacturers regularly engaged in the manufacture of such products and that essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Submit a complete list of materials, including manufacturer's descriptive technical literature, performance data, catalog cuts, and installation instructions. The product number, k-value, thickness and furnished accessories including adhesives, sealants and jackets for each mechanical system requiring insulation shall be included. The product data must be copyrighted, have an identifying or publication number, and shall have been published prior to the issuance date of this solicitation. Materials furnished under this section shall be submitted together in a booklet and in conjunction with the MICA plates booklet (SD-02). Annotate the product data to indicate which MICA plate is applicable.

2.1.1 Insulation System

Provide insulation systems in accordance with the approved MICA National Insulation Standards plates as supplemented by this specification. Provide field-applied insulation for heating, ventilating, and cooling (HVAC) air distribution systems and piping systems that are located within, on, under, and adjacent to buildings; and for plumbing systems. Provide CFC and HCFC free insulation.

2.1.2 Surface Burning Characteristics

Unless otherwise specified, insulation must have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84. Flame spread, and smoke developed indexes, shall be determined by ASTM E84 or UL 723. Test insulation in the same density and installed thickness as the material to be used in the actual construction. Prepare and mount test specimens according to

ASTM E2231.

2.2 MATERIALS

Provide insulation that meets or exceed the requirements of ASHRAE 90.2. Insulation exterior shall be cleanable, grease resistant, non-flaking and non-peeling. Materials shall be compatible and shall not contribute to corrosion, soften, or otherwise attack surfaces to which applied in either wet or dry state. Materials to be used on stainless steel surfaces shall meet ASTM C795 requirements. Calcium silicate shall not be used on chilled or cold water systems. Materials shall be asbestos free. Provide product recognized under UL 94 (if containing plastic) and listed in FM APP GUIDE.

2.2.1 Adhesives

Provide non-aerosol adhesive products used on the interior of the building (defined as inside of the weatherproofing system) that meet either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1168 (HVAC duct sealants must meet limit requirements of "Other" category within SCAQMD Rule 1168 sealants table). Provide aerosol adhesives used on the interior of the building that meet either emissions requirements of CDPH SECTION 01350 (use the office or classroom requirements, regardless of space type) or VOC content requirements of GS-36. Provide certification or validation of indoor air quality for adhesives.

2.2.1.1 Acoustical Lining Insulation Adhesive

Adhesive shall be a nonflammable, fire-resistant adhesive conforming to ASTM C916, Type I.

2.2.1.2 Mineral Fiber Insulation Cement

Cement shall be in accordance with ASTM C195.

2.2.1.3 Lagging Adhesive

Lagging is the material used for thermal insulation, especially around a cylindrical object. This may include the insulation as well as the cloth/material covering the insulation. To resist mold/mildew, lagging adhesive shall meet ASTM D5590 with 0 growth rating. Lagging adhesives shall be nonflammable and fire-resistant and shall have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84. Adhesive shall be MIL-A-3316, Class 1, pigmented white and be suitable for bonding fibrous glass cloth to faced and unfaced fibrous glass insulation board; for bonding cotton brattice cloth to faced and unfaced fibrous glass insulation board; for sealing edges of and bonding glass tape to joints of fibrous glass board; for bonding lagging cloth to thermal insulation; or Class 2 for attaching fibrous glass insulation to metal surfaces. Lagging adhesives shall be applied in strict accordance with the manufacturer's recommendations for pipe and duct insulation.

2.2.1.4 Contact Adhesive

Adhesives may be any of, but not limited to, the neoprene based, rubber based, or elastomeric type that have a maximum flame spread index of 25

and a maximum smoke developed index of 50 when tested in accordance with ASTM E84. The adhesive shall not adversely affect, initially or in service, the insulation to which it is applied, nor shall it cause any corrosive effect on metal to which it is applied. Any solvent dispersing medium or volatile component of the adhesive shall have no objectionable odor and shall not contain any benzene or carbon tetrachloride. The dried adhesive shall not emit nauseous, irritating, or toxic volatile matters or aerosols when the adhesive is heated to any temperature up to 212 degrees F. The dried adhesive shall be nonflammable and fire resistant. Flexible Elastomeric Adhesive: Comply with MIL-A-24179, Type II, Class I. Provide product listed in FM APP GUIDE.

2.2.2 Caulking

ASTM C920, Type S, Grade NS, Class 25, Use A.

2.2.3 Corner Angles

Nominal 0.016 inch aluminum 1 by 1 inch with factory applied kraft backing. Aluminum shall be ASTM B209, Alloy 3003, 3105, or 5005.

2.2.4 Fittings

Fabricated Fittings are the prefabricated fittings for flexible elastomeric pipe insulation systems in accordance with ASTM C1710. Together with the flexible elastomeric tubes, they provide complete system integrity for retarding heat gain and controlling condensation drip from chilled-water and refrigeration systems. Flexible elastomeric, fabricated fittings provide thermal protection (0.25 k) and condensation resistance (0.05 Water Vapor Transmission factor). For satisfactory performance, properly installed protective vapor retarder/barriers and vapor stops shall be used on high relative humidity and below ambient temperature applications to reduce movement of moisture through or around the insulation to the colder interior surface.

2.2.5 Finishing Cement

ASTM C450: Mineral fiber hydraulic-setting thermal insulating and finishing cement. All cements that may come in contact with Austenitic stainless steel must comply with ASTM C795.

2.2.6 Fibrous Glass Cloth and Glass Tape

Fibrous glass cloth, with 20X20 maximum mesh size, and glass tape shall have maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84. Tape shall be 4 inch wide rolls. Class 3 tape shall be 4.5 ounces/square yard. Elastomeric Foam Tape: Black vapor-retarder foam tape with acrylic adhesive containing an anti-microbial additive.

2.2.7 Staples

Outward clinching type ASTM A167, Type 304 or 316 stainless steel.

2.2.8 Jackets

2.2.8.1 Aluminum Jackets

Aluminum jackets shall be corrugated, embossed or smooth sheet, 0.016 inch

nominal thickness; ASTM B209, Temper H14, Temper H16, Alloy 3003, 5005, or 3105. Corrugated aluminum jacket shall not be used outdoors. Aluminum jacket securing bands shall be Type 304 stainless steel, 0.015 inch thick, 1/2 inch wide for pipe under 12 inch diameter and 3/4 inch wide for pipe over 12 inch and larger diameter. Aluminum jacket circumferential seam bands shall be 2 by 0.016 inch aluminum matching jacket material. Bands for insulation below ground shall be 3/4 by 0.020 inch thick stainless steel, or fiberglass reinforced tape. The jacket may, at the option of the Contractor, be provided with a factory fabricated Pittsburgh or "Z" type longitudinal joint. When the "Z" joint is used, the bands at the circumferential joints shall be designed by the manufacturer to seal the joints and hold the jacket in place.

2.2.8.2 Polyvinyl Chloride (PVC) Jackets

Polyvinyl chloride (PVC) jacket and fitting covers shall have high impact strength, ultraviolet (UV) resistant rating or treatment and moderate chemical resistance with minimum thickness 0.030 inch.

2.2.8.3 Vapor Barrier/Weatherproofing Jacket

Vapor barrier/weatherproofing jacket shall be laminated self-adhesive, greater than 3 plies standard grade, silver, white, black and embossed or greater than 8 ply (minimum 2.9 mils adhesive); with 0.0000 permeability when tested in accordance with ASTM E96/E96M, using the water transmission rate test method; heavy duty, white or natural; and UV resistant. Flexible Elastomeric exterior foam with factory applied, UV Jacket made with a cold weather acrylic adhesive. Construction of laminate designed to provide UV resistance, high puncture, tear resistance and excellent Water Vapor Transmission (WVT) rate.

2.2.8.4 Vapor Barrier/Vapor Retarder

Apply the following criteria to determine which system is required.

a. On ducts, piping and equipment operating below 60 degrees F or located outside shall be equipped with a vapor barrier.

b. Ducts, pipes and equipment that are located inside and that always operate above 60 degrees F shall be installed with a vapor retarder where required as stated in paragraph VAPOR RETARDER REQUIRED.

2.2.9 Vapor Retarder Required

ASTM C921, Type I, minimum puncture resistance 50 Beach units on all surfaces except concealed ductwork, where a minimum puncture resistance of 25 Beach units is acceptable. Minimum tensile strength, 35 pounds/inch width. ASTM C921, Type II, minimum puncture resistance 25 Beach units, tensile strength minimum 20 pounds/inch width. Jackets used on insulation exposed in finished areas shall have white finish suitable for painting without sizing. Based on the application, insulation materials that require manufacturer or fabricator applied pipe insulation jackets are cellular glass, when all joints are sealed with a vapor barrier mastic, and mineral fiber. All non-metallic jackets shall have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84. Flexible elastomerics require (in addition to vapor barrier skin) vapor retarder jacketing for high relative humidity and below ambient temperature applications.

2.2.9.1 White Vapor Retarder All Service Jacket (ASJ)

ASJ is for use on hot/cold pipes, ducts, or equipment indoors or outdoors if covered by a suitable protective jacket. The product shall meet all physical property and performance requirements of ASTM C1136, Type I, except the burst strength shall be a minimum of 85 psi. ASTM D2863 Limited Oxygen Index (LOI) shall be a minimum of 31.

In addition, neither the outer exposed surface nor the inner-most surface contacting the insulation shall be paper or other moisture-sensitive material. The outer exposed surface shall be white and have an emittance of not less than 0.80. The outer exposed surface shall be paintable.

2.2.9.2 Vapor Retarder/Vapor Barrier Mastic Coatings

2.2.9.2.1 Vapor Barrier

The vapor barrier shall be self adhesive (minimum 2 mils adhesive, 3 mils embossed) greater than 3 plies standard grade, silver, white, black and embossed white jacket for use on hot/cold pipes. Permeability shall be less than 0.02 when tested in accordance with ASTM E96/E96M. Products shall meet UL 723 or ASTM E84 flame and smoke requirements and shall be UV resistant.

2.2.9.2.2 Vapor Retarder

The vapor retarder coating shall be fire and water resistant and appropriately selected for either outdoor or indoor service. Color shall be white. The water vapor permeance of the compound shall be 0.013 perms or less at 43 mils dry film thickness as determined according to procedure B of ASTM E96/E96M utilizing apparatus described in ASTM E96/E96M. The coating shall be nonflammable, fire resistant type. To resist mold/mildew, coating shall meet ASTM D5590 with 0 growth rating. Coating shall meet MIL-PRF-19565 Type II (if selected for indoor service) and be Qualified Products Database listed. All other application and service properties shall be in accordance with ASTM C647.

2.2.9.3 Laminated Film Vapor Retarder

ASTM C1136, Type I, maximum moisture vapor transmission 0.02 perms, minimum puncture resistance 50 Beach units on all surfaces except concealed ductwork; where Type II, maximum moisture vapor transmission 0.02 perms, a minimum puncture resistance of 25 Beach units is acceptable. Vapor retarder shall have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84. Flexible Elastomeric exterior foam with factory applied UV Jacket. Construction of laminate designed to provide UV resistance, high puncture, tear resistance and an excellent WVT rate.

2.2.9.4 Polyvinylidene Chloride (PVDC) Film Vapor Retarder

The PVDC film vapor retarder shall have a maximum moisture vapor transmission of 0.02 perms, minimum puncture resistance of 150 Beach units, a minimum tensile strength in any direction of 30 lb/inch when tested in accordance with ASTM D882, and a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84.

2.2.9.5 Polyvinylidene Chloride Vapor Retarder Adhesive Tape

Requirements must meet the same as specified for Laminated Film Vapor Retarder above.

2.2.9.6 Vapor Barrier/Weather Barrier

The vapor barrier shall be greater than 3 ply self adhesive laminate -white vapor barrier jacket- superior performance (less than 0.0000 permeability when tested in accordance with ASTM E96/E96M). Vapor barrier shall meet UL 723 or ASTM E84 25 flame and 50 smoke requirements; and UV resistant. Minimum burst strength 185 psi in accordance with ISO 2758. Tensile strength 68 lb/inch width (PSTC-1000). Tape shall be as specified for laminated film vapor barrier above.

2.2.10 Vapor Retarder Not Required

ASTM C921, Type II, Class D, minimum puncture resistance 50 Beach units on all surfaces except ductwork, where Type IV, maximum moisture vapor transmission 0.10, a minimum puncture resistance of 25 Beach units is acceptable. Jacket shall have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84.

2.2.11 Wire

Soft annealed ASTM A580/A580M Type 302, 304 or 316 stainless steel, 16 or 18 gauge.

2.2.12 Insulation Bands

Insulation bands shall be 1/2 inch wide; 26 gauge stainless steel.

2.2.13 Sealants

Sealants shall be chosen from the butyl polymer type, the styrene-butadiene rubber type, or the butyl type of sealants. Sealants shall have a maximum permeance of 0.02 perms based on Procedure B for ASTM E96/E96M, and a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84.

2.3 PIPE INSULATION SYSTEMS

Conform insulation materials to Table 1 and minimum insulation thickness as listed in Table 2 and meet or exceed the requirements of ASHRAE 90.1 - SI. Limit pipe insulation materials to those listed herein and meeting the following requirements:

2.3.1 Recycled Materials

Provide insulation materials containing the following minimum percentage of recycled material content by weight:

Rock Wool: 75 percent slag of weight
Fiberglass: 20 percent glass cullet
Rigid Foam: 9 percent recovered material
Phenolic Rigid Foam: 9 percent recovered material

Provide data identifying percentage of recycled content for insulation materials.

2.3.2 Aboveground Cold Pipeline (-30 to 60 deg. F)

Insulation for outdoor, indoor, exposed or concealed applications, shall be as follows:

2.3.2.1 Cellular Glass

ASTM C552, Type II, and Type III. Supply the insulation from the fabricator with (paragraph WHITE VAPOR RETARDER ALL SERVICE JACKET (ASJ)) ASJ vapor retarder and installed with all longitudinal overlaps sealed and all circumferential joints ASJ taped or supply the insulation unfaced from the fabricator and install with all longitudinal and circumferential joints sealed with vapor barrier mastic.

2.3.2.2 Flexible Elastomeric Cellular Insulation

Closed-cell, foam- or expanded-rubber materials containing anti-microbial additive, complying with ASTM C534/C534M, Grade 1, Type I or II. Type I, Grade 1 for tubular materials. Type II, Grade 1, for sheet materials. Type I and II shall have vapor retarder/vapor barrier skin on one or both sides of the insulation, and require an additional exterior vapor retarder covering for high relative humidity and below ambient temperature applications.

2.3.2.3 Mineral Fiber Insulation with Integral Wicking Material (MFIWM)

ASTM C547. Install in accordance with manufacturer's instructions. Do not use in applications exposed to outdoor ambient conditions in climatic zones 1 through 4.

2.3.2.4 Polyisocyanurate Insulation

ASTM C591, Type I. Supply the insulation with a factory applied vapor retarder/barrier that complies with Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. The insulation and all covering must pass the flame spread index of 25 and the smoke developed index of 50 when tested in accordance with ASTM E84.

2.3.3 Aboveground Hot Pipeline (Above 60 deg. F)

Insulation for outdoor, indoor, exposed or concealed applications shall meet the following requirements. Supply the insulation with manufacturer's recommended factory-applied jacket/vapor barrier.

2.3.3.1 Mineral Fiber

ASTM C547, Types I, II or III, supply the insulation with manufacturer's recommended factory-applied jacket.

2.3.3.2 Calcium Silicate

ASTM C533, Type I indoor only, or outdoors above 250 degrees F pipe temperature. Supply insulation with the manufacturer's recommended factory-applied jacket/vapor barrier.

2.3.3.3 Cellular Glass

ASTM C552, Type II and Type III. Supply the insulation with

manufacturer's recommended factory-applied jacket.

2.3.3.4 Flexible Elastomeric Cellular Insulation

Closed-cell, foam- or expanded-rubber materials containing anti-microbial additive, complying with ASTM C534/C534M, Grade 1, Type I or II to 220 degrees F service. Type I for tubular materials. Type II for sheet materials.

2.3.3.5 Phenolic Insulation

ASTM C1126 Type III to 250 degrees F service shall comply with ASTM C795. Supply the insulation with manufacturer's recommended factory-applied jacket/vapor barrier.

2.3.3.6 Perlite Insulation

ASTM C610

2.3.3.7 Polyisocyanurate Insulation

ASTM C591, Type I. Supply the insulation with a factory applied vapor retarder/barrier that complies with Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. The insulation and all covering must pass the flame spread index of 25 and the smoke developed index of 50 when tested in accordance with ASTM E84.

2.3.4 Below-ground Pipeline Insulation

For below-ground pipeline insulation, use cellular glass, ASTM C552, type II.

2.4 DUCT INSULATION SYSTEMS

2.4.1 Factory Applied Insulation

Provide factory-applied ASTM C552, cellular glass thermal ASTM C534/C534M Grade 1, Type II, flexible elastomeric closed cell insulation according to manufacturer's recommendations for insulation with insulation manufacturer's standard reinforced fire-retardant vapor barrier, with identification of installed thermal resistance (R) value and out-of-package R value.

2.4.1.1 Rigid Insulation

Calculate the minimum thickness in accordance with ASHRAE 90.1 - IP.

2.4.1.2 Blanket Insulation

Calculate minimum thickness in accordance with ASHRAE 90.1 - IP..

2.4.2 Acoustical Duct Lining

2.4.2.1 General

For ductwork indicated or specified in Section 23 00 00 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM to be acoustically lined, provide external insulation in accordance with this specification section and in addition to the acoustical duct lining. Do not use acoustical

lining in place of duct wrap or rigid board insulation (insulation on the exterior of the duct).

2.4.2.2 Duct Liner

Flexible Elastomeric Acoustical and Conformable Duct Liner Materials: Flexible Elastomeric Thermal, Acoustical and Conformable Insulation Compliance with ASTM C534/C534M Grade 1, Type II; and NFPA 90A or NFPA 90B as applicable.

2.4.3 Duct Insulation Jackets

2.4.3.1 All-Purpose Jacket

Provide insulation with insulation manufacturer's standard reinforced fire-retardant jacket with or without integral vapor barrier as required by the service. In exposed locations, provide jacket with a white surface suitable for field painting.

2.4.3.2 Metal Jackets

2.4.3.2.1 Aluminum Jackets

ASTM B209, Temper H14, minimum thickness of 27 gauge (0.016 inch), with factory-applied polyethylene and kraft paper moisture barrier on inside surface. Provide smooth surface jackets for jacket outside dimension 8 inches and larger. Provide corrugated surface jackets for jacket outside dimension 8 inches and larger. Provide stainless steel bands, minimum width of 1/2 inch.

2.4.3.2.2 Stainless Steel Jackets

ASTM A167 or ASTM A240/A240M; Type 304, minimum thickness of 33 gauge (0.010 inch), smooth surface with factory-applied polyethylene and kraft paper moisture barrier on inside surface. Provide stainless steel bands, minimum width of 1/2 inch.

2.4.3.3 Vapor Barrier/Weatherproofing Jacket

Vapor barrier/weatherproofing jacket shall be laminated self-adhesive (minimum 2 mils adhesive, 3 mils embossed) less than 0.0000 permeability, (greater than 3 ply, standard grade, silver, white, black and embossed or greater than 8 ply (minimum 2.9 mils adhesive), heavy duty white or natural).

2.4.4 Weatherproof Duct Insulation

Provide ASTM C534/C534M Grade 1, Type II, flexible elastomeric cellular insulation, and weatherproofing as specified in manufacturer's instruction. Multi-ply, Polymeric Blend Laminate Jacketing: Construction of laminate designed to provide UV resistance, high puncture, tear resistance and an excellent WVT rate.

2.5 ACOUSTICAL BARRIER WRAP

2.5.1 Acceptable Manufacturers

a. Kinetics Noise Control (Basis of Design)
b. American Acoustical Products

c. Approved Equal

General: Provide combination of limp, flexible loaded vinyl noise barriers permanently factory laminated to a polyester urethane absorption foam. Each composite foam shall be classified as #94HF-1 as specified by UL 94 Flame Retardancy Tests.

The limp mass barrier shall be barium sulphate loaded, unreinforced PVC material, nominally weighing 0.5 or 1.0 lbs/sq ft.

The bonded absorption or decoupling layer shall be 2 PCF density, polyester urethane, flexible, acoustical foam have a Noise Reduction Coeffecient (NRC) of 0.27 for ¼ inch, 0.49 for ½ inch and 0.73 for 1 inch thicknesses when used as a limited length, free hanging barrier with foam facing the noise source.

Composite materials shall have following minimum transmission loss when adhered to 18 gauge sheet metal and set into test according to ASTM E336 or ASTM E90.

Sound Transmission Loss (dB)
Frequency (Hz)

125	250	500	1000	2000	4000	STC
18	26	39	54	55	53	39

Material for lapping joints same as limp mass barrier. Adhesive for laminating layers of barrier material shall be as recommended by manufacturer of the barrier material. Coordinate with duct insulation material and installation

2.6 EQUIPMENT INSULATION SYSTEMS

Insulate equipment and accessories as specified in Tables 5 and 6. In outside locations, provide insulation 1/2 inch thicker than specified. Increase the specified insulation thickness for equipment where necessary to equal the thickness of angles or other structural members to make a smooth, exterior surface. Submit a booklet containing manufacturer's published installation instructions for the insulation systems in coordination with the submitted MICA Insulation Stds plates booklet. Annotate their installation instructions to indicate which product data and which MICA plate are applicable. The instructions must be copyrighted, have an identifying or publication number, and shall have been published prior to the issuance date of this solicitation. A booklet is also required by paragraphs titled: Pipe Insulation Systems and Duct Insulation Systems.

PART 3 EXECUTION

3.1 APPLICATION - GENERAL

Insulation shall only be applied to unheated and uncooled piping and equipment. Flexible elastomeric cellular insulation shall not be compressed at joists, studs, columns, ducts, hangers, etc. The insulation shall not pull apart after a one hour period; any insulation found to pull apart after one hour, shall be replaced.

3.1.1 Display Samples

Submit and display, after approval of materials, actual sections of

installed systems, properly insulated in accordance with the specification requirements. Such actual sections must remain accessible to inspection throughout the job and will be reviewed from time to time for controlling the quality of the work throughout the construction site. Each material used shall be identified, by indicating on an attached sheet the specification requirement for the material and the material by each manufacturer intended to meet the requirement. The Contracting Officer will inspect display sample sections at the jobsite. Approved display sample sections shall remain on display at the jobsite during the construction period. Upon completion of construction, the display sample sections will be closed and sealed.

3.1.1.1 Pipe Insulation Display Sections

Display sample sections shall include as a minimum an elbow or tee, a valve, dielectric waterways and flanges, a hanger with protection shield and insulation insert, or dowel as required, at support point, method of fastening and sealing insulation at longitudinal lap, circumferential lap, butt joints at fittings and on pipe runs, and terminating points for each type of pipe insulation used on the job, and for hot pipelines and cold pipelines, both interior and exterior, even when the same type of insulation is used for these services.

3.1.1.2 Duct Insulation Display Sections

Display sample sections for rigid and flexible duct insulation used on the job. Use a temporary covering to enclose and protect display sections for duct insulation exposed to weather

3.1.2 Installation

Except as otherwise specified, material shall be installed in accordance with the manufacturer's written instructions. Insulation materials shall not be applied until tests and heat tracing specified in other sections of this specification are completed. Material such as rust, scale, dirt and moisture shall be removed from surfaces to receive insulation. Insulation shall be kept clean and dry. Insulation shall not be removed from its shipping containers until the day it is ready to use and shall be returned to like containers or equally protected from dirt and moisture at the end of each workday. Insulation that becomes dirty shall be thoroughly cleaned prior to use. If insulation becomes wet or if cleaning does not restore the surfaces to like new condition, the insulation will be rejected, and shall be immediately removed from the jobsite. Joints shall be staggered on multi layer insulation. Mineral fiber thermal insulating cement shall be mixed with demineralized water when used on stainless steel surfaces. Insulation, jacketing and accessories shall be installed in accordance with MICA Insulation Stds plates except where modified herein or on the drawings.

3.1.3 Firestopping

Where pipes and ducts pass through fire walls, fire partitions, above grade floors, and fire rated chase walls, the penetration shall be sealed with fire stopping materials as specified in Section 07 84 00 FIRESTOPPING. The protection of ducts at point of passage through firewalls must be in accordance with NFPA 90A and/or NFPA 90B. All other penetrations, such as piping, conduit, and wiring, through firewalls must be protected with a material or system of the same hourly rating that is listed by UL, FM, or a NRTL.

3.1.4 Painting and Finishing

Painting shall be as specified in Section 09 90 00 PAINTS AND COATINGS.

3.1.5 Installation of Flexible Elastomeric Cellular Insulation

Install flexible elastomeric cellular insulation with seams and joints sealed with rubberized contact adhesive. Flexible elastomeric cellular insulation shall not be used on surfaces greater than 220 degrees F. Stagger seams when applying multiple layers of insulation. Protect insulation exposed to weather and not shown to have vapor barrier weatherproof jacketing with two coats of UV resistant finish or PVC or metal jacketing as recommended by the manufacturer after the adhesive is dry and cured.

3.1.5.1 Adhesive Application

Apply a brush coating of adhesive to both butt ends to be joined and to both slit surfaces to be sealed. Allow the adhesive to set until dry to touch but tacky under slight pressure before joining the surfaces. Insulation seals at seams and joints shall not be capable of being pulled apart one hour after application. Insulation that can be pulled apart one hour after installation shall be replaced.

3.1.5.2 Adhesive Safety Precautions

Use natural cross-ventilation, local (mechanical) pickup, and/or general area (mechanical) ventilation to prevent an accumulation of solvent vapors, keeping in mind the ventilation pattern must remove any heavier-than-air solvent vapors from lower levels of the workspaces. Gloves and spectacle-type safety glasses are recommended in accordance with safe installation practices.

3.1.6 Welding

No welding shall be done on piping, duct or equipment without written approval of the Contracting Officer. The capacitor discharge welding process may be used for securing metal fasteners to duct.

3.1.7 Pipes/Ducts/Equipment That Require Insulation

Insulation is required on all pipes, ducts, or equipment, except for omitted items as specified.

3.2 PIPE INSULATION SYSTEMS INSTALLATION

Install pipe insulation systems in accordance with the approved MICA Insulation Stds plates as supplemented by the manufacturer's published installation instructions.

3.2.1 Pipe Insulation

3.2.1.1 General

Pipe insulation shall be installed on aboveground hot and cold pipeline systems as specified below to form a continuous thermal retarder/barrier, including straight runs, fittings and appurtenances unless specified otherwise. Installation shall be with full length units of insulation and

using a single cut piece to complete a run. Cut pieces or scraps abutting each other shall not be used. Pipe insulation shall be omitted on the following:

a. Pipe used solely for fire protection.

b. Chromium plated pipe to plumbing fixtures. However, fixtures for use by the physically handicapped shall have the hot water supply and drain, including the trap, insulated where exposed.

c. Sanitary drain lines.

d. Air chambers.

e. Adjacent insulation.

f. ASME stamps.

g. Access plates of fan housings.

h. Cleanouts or handholes.

3.2.1.2 Pipes Passing Through Walls, Roofs, and Floors

Pipe insulation shall be continuous through the sleeve.

Provide an aluminum jacket or vapor barrier/weatherproofing self adhesive jacket (minimum 2 mils adhesive, 3 mils embossed) less than 0.0000 permeability, greater than 3 ply standard grade, silver, white, black and embossed with factory applied moisture retarder over the insulation wherever penetrations require sealing.

3.2.1.2.1 Penetrate Interior Walls

The aluminum jacket or vapor barrier/weatherproofing - self adhesive jacket (minimum 2 mils adhesive, 3 mils embossed) less than 0.0000 permeability, greater than 3 plies standard grade, silver, white, black and embossed shall extend 2 inches beyond either side of the wall and shall be secured on each end with a band.

3.2.1.2.2 Penetrating Floors

Extend the aluminum jacket from a point below the backup material to a point 10 inches above the floor with one band at the floor and one not more than 1 inch from the end of the aluminum jacket.

3.2.1.2.3 Penetrating Waterproofed Floors

Extend the aluminum jacket rom below the backup material to a point 2 inches above the flashing with a band 1 inch from the end of the aluminum jacket.

3.2.1.2.4 Penetrating Exterior Walls

Continue the aluminum jacket required for pipe exposed to weather through the sleeve to a point 2 inches beyond the interior surface of the wall.

3.2.1.2.5 Penetrating Roofs

Insulate pipe as required for interior service to a point flush with the top of the flashing and sealed with flashing sealant. Tightly butt the insulation for exterior application to the top of flashing and interior insulation. Extend the exterior aluminum jacket 2 inches down beyond the end of the insulation to form a counter flashing. Seal the flashing and counter flashing underneath with metal jacketing/flashing sealant.

3.2.1.3 Pipes Passing Through Hangers

Insulation, whether hot or cold application, shall be continuous through hangers. All horizontal pipes 2 inches and smaller shall be supported on hangers with the addition of a Type 40 protection shield to protect the insulation in accordance with MSS SP-58. Whenever insulation shows signs of being compressed, or when the insulation or jacket shows visible signs of distortion at or near the support shield, insulation inserts as specified below for piping larger than 2 inches shall be installed, or factory insulated hangers (designed with a load bearing core) can be used.

3.2.1.3.1 Horizontal Pipes Larger Than 2 Inches at 60 Degrees F and Above

Supported on hangers in accordance with MSS SP-58, and Section 22 00 00 PLUMBING, GENERAL PURPOSE.

3.2.1.3.2 Horizontal Pipes Larger Than 2 Inches and Below 60 Degrees F

Supported on hangers with the addition of a Type 40 protection shield in accordance with MSS SP-58. An insulation insert of cellular glass, prefabricated insulation pipe hangers, or perlite above 80 degrees F shall be installed above each shield. The insert shall cover not less than the bottom 180-degree arc of the pipe. Inserts shall be the same thickness as the insulation, and shall extend 2 inches on each end beyond the protection shield. When insulation inserts are required in accordance with the above, and the insulation thickness is less than 1 inch, wooden or cork dowels or blocks may be installed between the pipe and the shield to prevent the weight of the pipe from crushing the insulation, as an option to installing insulation inserts. The insulation jacket shall be continuous over the wooden dowel, wooden block, or insulation insert.

3.2.1.3.3 Vertical Pipes

Supported with either Type 8 or Type 42 riser clamps with the addition of two Type 40 protection shields in accordance with MSS SP-58 covering the 360-degree arc of the insulation. An insulation insert of cellular glass or calcium silicate shall be installed between each shield and the pipe. The insert shall cover the 360-degree arc of the pipe. Inserts shall be the same thickness as the insulation, and shall extend 2 inches on each end beyond the protection shield. When insulation inserts are required in accordance with the above, and the insulation thickness is less than 1 inch, wooden or cork dowels or blocks may be installed between the pipe and the shield to prevent the hanger from crushing the insulation, as an option instead of installing insulation inserts. The insulation jacket shall be continuous over the wooden dowel, wooden block, or insulation insert. The vertical weight of the pipe shall be supported with hangers located in a horizontal section of the pipe. When the pipe riser is longer than 30 feet, the weight of the pipe shall be additionally supported with hangers in the vertical run of the pipe that are directly clamped to the pipe, penetrating the pipe insulation. These hangers shall be insulated and the

insulation jacket sealed as indicated herein for anchors in a similar service.

3.2.1.3.4 Inserts

Covered with a jacket material of the same appearance and quality as the adjoining pipe insulation jacket, overlap the adjoining pipe jacket 1-1/2 inches, and seal as required for the pipe jacket. The jacket material used to cover inserts in flexible elastomeric cellular insulation shall conform to ASTM C1136, Type 1, and is allowed to be of a different material than the adjoining insulation material.

3.2.1.4 Flexible Elastomeric Cellular Pipe Insulation

Flexible elastomeric cellular pipe insulation shall be tubular form for pipe sizes 6 inches and less. Grade 1, Type II sheet insulation used on pipes larger than 6 inches shall not be stretched around the pipe. On pipes larger than 12 inches, the insulation shall be adhered directly to the pipe on the lower 1/3 of the pipe. Seams shall be staggered when applying multiple layers of insulation. Sweat fittings shall be insulated with miter-cut pieces the same size as on adjacent piping. Screwed fittings shall be insulated with sleeved fitting covers fabricated from miter-cut pieces and shall be overlapped and sealed to the adjacent pipe insulation. Type II requires an additional exterior vapor retarder/barrier covering for high relative humidity and below ambient temperature applications.

3.2.1.5 Pipes in high abuse areas.

In high abuse areas such as janitor closets and traffic areas in equipment rooms, kitchens, and mechanical rooms, aluminum or flexible laminate cladding (comprised of elastomeric, plastic or metal foil laminate) laminated self-adhesive (minimum 2 mils adhesive, 3 mils embossed) vapor barrier/weatherproofing jacket, - less than 0.0000 permeability; (greater than 3 ply, standard grade, silver, white, black and embossed) aluminum jackets shall be utilized. Pipe insulation to the 6 foot level shall be protected.

3.2.1.6 Pipe Insulation Material and Thickness

Pipe insulation materials must be as listed in Table 1 and must meet or exceed the requirements of ASHRAE 90.1 - IP.

TABLE 1

Insulation Material for Piping

Service					
	Material	Specification	Type	Class	VR/VB Req'd
Chilled Water (Supply & Return, Dual Temperature Piping, 40 F nominal)					
	Cellular Glass	ASTM C552	II	2	Yes
	Flexible Elastomeric Cellular	ASTM C534/C534M	I		Yes

TABLE 1					
Insulation Material for Piping					
Service					
	Material	Specification	Type	Class	VR/VB Req'd
	Mineral Fiber with Wicking Material	ASTM C547	I		Yes
Heating Hot Water Supply & Return, Heated Oil (Max 250 F)					
	Mineral Fiber	ASTM C547	I	1	No
	Calcium Silicate	ASTM C533	I		No
	Cellular Glass	ASTM C552	II	2	No
	Faced Phenolic Foam	ASTM C1126	III		Yes
	Perlite	ASTM C610			No
	Flexible Elastomeric Cellular	ASTM C534/C534M	I	2	No
Cold Domestic Water Piping, Makeup Water & Drinking Fountain Drain Piping					
	Cellular Glass	ASTM C552	II	2	No
	Flexible Elastomeric Cellular	ASTM C534/C534M	I		No
Hot Domestic Water Supply & Recirculating Piping (Max 200 F)					
	Mineral Fiber	ASTM C547	I	1	No
	Cellular Glass	ASTM C552	II	2	No
	Flexible Elastomeric Cellular	ASTM C534/C534M	I		No
	Faced Phenolic Foam	ASTM C1126	III		Yes
Refrigerant Suction Piping (35 degrees F nominal)					
	Flexible Elastomeric Cellular	ASTM C534/C534M	I		No
	Cellular Glass	ASTM C552	II	1	Yes
Compressed Air Discharge, Steam and Condensate Return (201 to 250 Degrees F					
	Cellular Glass	ASTM C552	II		No
	Mineral Fiber	ASTM C547	I	1	No
	Calcium Silicate	ASTM C533	I		No
	Faced Phenolic Foam	ASTM C1126	III		Yes
	Perlite	ASTM C610			No
	Flexible Elastomeric Cellular	ASTM C534/C534M	I	2	No

TABLE 1					
Insulation Material for Piping					
Service					
	Material	Specification	Type	Class	VR/VB Req'd
Exposed Lavatory Drains, Exposed Domestic Water Piping & Drains to Areas for Handicapped Personnel					
	Flexible Elastomeric Cellular	ASTM C534/C534M	I		No
Horizontal Roof Drain Leaders (Including Underside of Roof Drain Fittings)					
	Flexible Elastomeric Cellular	ASTM C534/C534M	I		No
	Faced Phenolic Foam	ASTM C1126	III		Yes
	Cellular Glass	ASTM C552	III		Yes
Condensate Drain Located Inside Building					
	Cellular Glass	ASTM C552	II	2	No
	Flexible Elastomeric Cellular	ASTM C534/C534M	I		No
Medium Temperature Hot Water, Steam and Condensate (251 to 350 Degrees F)					
	Mineral Fiber	ASTM C547	I	1	No
	Calcium Silicate	ASTM C533	I		No
	Cellular Glass	ASTM C552	I or II		No
	Perlite	ASTM C610			No
	Flexible Elastomeric Cellular	ASTM C534/C534M	I	2	No
High Temperature Hot Water & Steam (351 to 700 Degrees F)					
	Mineral Fiber	ASTM C547	I	2	No
	Calcium Silicate	ASTM C533	I		No
	Perlite	ASTM C610			No
	Cellular Glass	ASTM C552			No
Brine Systems Cryogenics (-30 to 0 Degrees F)					
	Cellular Glass	ASTM C552	II	2	No
	Flexible Elastomeric Cellular	ASTM C534/C534M	I		No

TABLE 2

Piping Insulation Thickness (inch)
Do not use integral wicking material in Chilled water applications exposed to outdoor ambient conditions in climatic zones 1 through 4.

Service	Material	Tube And Pipe Size (inch)				
		<1	1-<1.5	1.5-<4	4-<8	> or = >8
Chilled Water (Supply & Return, Dual Temperature Piping, 40 Degrees F nominal)						
	Cellular Glass	1.5	2	2	2.5	3
	Mineral Fiber with Wicking Material	1	1.5	1.5	2	2
	Flexible Elastomeric Cellular	1	1	1	N/A	N/A
Chilled Water (Supply & Return, Dual Temperature Piping, 40 Degrees F nominal)						
	Cellular Glass	1.5	1.5	1.5	1.5	2
	Flexible Elastomeric Cellular	1	1	1	N/A	N/A
	Mineral Fiber with Wicking Material	1	1.5	1.5	2	2
Heating Hot Water Supply & Return, Heated Oil (Max 250 F)						
	Mineral Fiber	1.5	1.5	2	2	2
	Calcium Silicate	2.5	2.5	3	3	3
	Cellular Glass	2	2.5	3	3	3
	Perlite	2.5	2.5	3	3	3
	Flexible Elastomeric Cellular	1	1	1	N/A	N/A
Cold Domestic Water Piping, Makeup Water & Drinking Fountain Drain Piping						
	Cellular Glass	1.5	1.5	1.5	1.5	1.5
	Flexible Elastomeric Cellular	1	1	1	N/A	N/A
Hot Domestic Water Supply & Recirculating Piping (Max 200 F)						
	Mineral Fiber	1	1	1	1.5	1.5
	Cellular Glass	1.5	1.5	1.5	2	2
	Flexible Elastomeric Cellular	1	1	1	N/A	N/A
Refrigerant Suction Piping (35 degrees F nominal)						

TABLE 2						
Piping Insulation Thickness (inch) Do not use integral wicking material in Chilled water applications exposed to outdoor ambient conditions in climatic zones 1 through 4.						
Service						
	Material	Tube And Pipe Size (inch)				
		<1	1-<1.5	1.5-<4	4-<8	> or = >8
	Flexible Elastomeric Cellular	1	1	1	N/A	N/A
	Cellular Glass	1.5	1.5	1.5	1.5	1.5
Compressed Air Discharge, Steam and Condensate Return (201 to 250 Degrees F						
	Mineral Fiber	1.5	1.5	2	2	2
		1.5*	2*	2.5*	3*	3.5*
	Calcium Silicate	2.5	3	4	4	4.5
	Cellular Glass	2	2.5	3	3	3
	Perlite	2.5	3	4	4	4.5
	Flexible Elastomeric Cellular	1	1	1	N/A	N/A
Exposed Lavatory Drains, Exposed Domestic Water Piping & Drains to Areas for Handicapped Personnel						
	Flexible Elastomeric Cellular	0.5	0.5	0.5	0.5	0.5
Horizontal Roof Drain Leaders (Including Underside of Roof Drain Fittings)						
	Cellular Glass	1.5	1.5	1.5	1.5	1.5
	Flexible Elastomeric Cellular	1	1	1	N/A	N/A
	Faced Phenolic Foam	1	1	1	1	1
Condensate Drain Located Inside Building						
	Cellular Glass	1.5	1.5	1.5	1.5	1.5
	Flexible Elastomeric Cellular	1	1	1	N/A	N/A
Medium Temperature Hot Water, Steam and Condensate (251 to 350 Degrees F)						
	Mineral Fiber	1.5	3	3	4	4
		2.5*	*	3.5*		
	Calcium Silicate	2.5	3.5	4.5	4.5	5

TABLE 2						
Piping Insulation Thickness (inch) Do not use integral wicking material in Chilled water applications exposed to outdoor ambient conditions in climatic zones 1 through 4.						
Service						
	Material	Tube And Pipe Size (inch)				
		<1	1-<1.5	1.5-<4	4-<8	> or = >8
	Perlite	2.5	3.5	4.5	4.5	5
	Flexible Elastomeric Cellular	1	1	1	N/A	N/A
High Temperature Hot Water & Steam (351 to 700 Degrees F)						
	Mineral Fiber	2.5	3	3	4	4
	Calcium Silicate	4	4.5	6	6	6
	Perlite	4	4.5	6	6	6

3.2.2 Aboveground Cold Pipelines

The following cold pipelines for minus 30 to plus 60 degrees F, shall be insulated in accordance with Table 2 except those piping listed in subparagraph Pipe Insulation in PART 3 as to be omitted. This includes but is not limited to the following:

a. Make-up water.

b. Horizontal and vertical portions of interior roof drains.

c. Refrigerant suction lines.

d. Chilled water.

e. Dual temperature water, i.e. HVAC hot/chilled water.

f. Air conditioner condensate drains.

g. Exposed lavatory drains and domestic water lines serving plumbing fixtures for handicap persons.

h. Domestic cold and chilled drinking water.

3.2.2.1 Insulation Material and Thickness

Insulation thickness for cold pipelines shall be determined using Table 2.

3.2.2.2 Factory or Field applied Jacket

Insulation shall be covered with a factory applied vapor retarder jacket/vapor barrier or field applied seal welded PVC jacket or greater than 3 ply laminated self-adhesive (minimum 2 mils adhesive, 3 mils embossed) vapor barrier/weatherproofing jacket - less than 0.0000

permeability, standard grade, sliver, white, black and embossed for use with Mineral Fiber, Cellular Glass, and Phenolic Foam Insulated Pipe. Insulation inside the building, to be protected with an aluminum jacket or greater than 3ply vapor barrier/weatherproofing self-adhesive (minimum 2 mils adhesive, 3 mils embossed) product, less than 0.0000 permeability, standard grade, Embossed Silver, White & Black, shall have the insulation and vapor retarder jacket installed as specified herein. The aluminum jacket or greater than 3ply vapor barrier/weatherproofing self-adhesive (minimum 2 mils adhesive, 3 mils embossed) product, less than 0.0000 permeability, standard grade, embossed silver, White & Black, shall be installed as specified for piping exposed to weather, except sealing of the laps of the aluminum jacket is not required. In high abuse areas such as janitor closets and traffic areas in equipment rooms, kitchens, and mechanical rooms, aluminum jackets or greater than 3ply vapor barrier/weatherproofing self-adhesive (minimum 2 mils adhesive, 3 mils embossed) product, less than 0.0000 permeability, standard grade, embossed silver, white & black, shall be provided for pipe insulation to the 6 ft level.

3.2.2.3 Installing Insulation for Straight Runs Hot and Cold Pipe

Apply insulation to the pipe with tight butt joints. Seal all butted joints and ends with joint sealant and seal with a vapor retarder coating, greater than 3 ply laminate jacket - less than 0.0000 perm adhesive tape or PVDC adhesive tape.

3.2.2.3.1 Longitudinal Laps of the Jacket Material

Overlap not less than 1-1/2 inches. Provide butt strips 3 inches wide for circumferential joints.

3.2.2.3.2 Laps and Butt Strips

Secure with adhesive and staple on 4 inch centers if not factory self-sealing. If staples are used, seal in accordance with paragraph STAPLES below. Note that staples are not required with cellular glass systems.

3.2.2.3.3 Factory Self-Sealing Lap Systems

May be used when the ambient temperature is between 40 and 120 degrees F during installation. Install the lap system in accordance with manufacturer's recommendations. Use a stapler only if specifically recommended by the manufacturer. Where gaps occur, replace the section or repair the gap by applying adhesive under the lap and then stapling.

3.2.2.3.4 Staples

Coat all staples, including those used to repair factory self-seal lap systems, with a vapor retarder coating or PVDC adhesive tape or greater than 3 ply laminate jacket - less than 0.0000 perm adhesive tape. Coat all seams, except those on factory self-seal systems, with vapor retarder coating or PVDC adhesive tape or greater than 3 ply laminate jacket - less than 0.0000 perm adhesive tape.

3.2.2.3.5 Breaks and Punctures in the Jacket Material

Patch by wrapping a strip of jacket material around the pipe and secure it with adhesive, staple, and coat with vapor retarder coating or PVDC

adhesive tape or greater than 3 ply laminate jacket - less than 0.0000 perm adhesive tape. Extend the patch not less than 1-1/2 inches past the break.

3.2.2.3.6 Penetrations Such as Thermometers

Fill the voids in the insulation and seal with vapor retarder coating or PVDC adhesive tape or greater than 3 ply laminate jacket - less than 0.0000 perm adhesive tape.

3.2.2.3.7 Flexible Elastomeric Cellular Pipe Insulation

Install by slitting the tubular sections and applying them onto the piping or tubing. Alternately, whenever possible slide un-slit sections over the open ends of piping or tubing. Secure all seams and butt joints and seal with adhesive. When using self seal products only the butt joints shall be secured with adhesive. Push insulation on the pipe, never pulled. Stretching of insulation may result in open seams and joints. Clean cut all edges. Rough or jagged edges of the insulation are not be permitted. Use proper tools such as sharp knives. Do not stretch Grade 1, Type II sheet insulation around the pipe when used on pipe larger than 6 inches. On pipes larger than 12 inches, adhere sheet insulation directly to the pipe on the lower 1/3 of the pipe.

3.2.2.4 Insulation for Fittings and Accessories

a. Pipe insulation shall be tightly butted to the insulation of the fittings and accessories. The butted joints and ends shall be sealed with joint sealant and sealed with a vapor retarder coating or PVDC adhesive tape or greater than 3 ply laminate jacket - less than 0.0000 perm adhesive tape.

b. Precut or preformed insulation shall be placed around all fittings and accessories and shall conform to MICA plates except as modified herein: 5 for anchors; 10, 11, and 13 for fittings; 14 for valves; and 17 for flanges and unions. Insulation shall be the same insulation as the pipe insulation, including same density, thickness, and thermal conductivity. Where precut/preformed is unavailable, rigid preformed pipe insulation sections may be segmented into the shape required. Insulation of the same thickness and conductivity as the adjoining pipe insulation shall be used. If nesting size insulation is used, the insulation shall be overlapped 2 inches or one pipe diameter. Elbows insulated using segments shall conform to MICA Tables 12.20 "Mitered Insulation Elbow'. Submit a booklet containing completed MICA Insulation Stds plates detailing each insulating system for each pipe, duct, or equipment insulating system, after approval of materials and prior to applying insulation.

(1) The MICA plates shall detail the materials to be installed and the specific insulation application. Submit all MICA plates required showing the entire insulating system, including plates required to show insulation penetrations, vessel bottom and top heads, legs, and skirt insulation as applicable. The MICA plates shall present all variations of insulation systems including locations, materials, vaporproofing, jackets and insulation accessories.

(2) If the Contractor elects to submit detailed drawings instead of edited MICA Plates, the detail drawings shall be technically

equivalent to the edited MICA Plate submittal.

c. Upon completion of insulation installation on flanges, unions, valves, anchors, fittings and accessories, terminations, seams, joints and insulation not protected by factory vapor retarder jackets or PVC fitting covers shall be protected with PVDC or greater than 3 ply laminate jacket - less than 0.0000 perm adhesive tape or two coats of vapor retarder coating with a minimum total thickness of 1/16 inch, applied with glass tape embedded between coats. Tape seams shall overlap 1 inch. The coating shall extend out onto the adjoining pipe insulation 2 inches. Fabricated insulation with a factory vapor retarder jacket shall be protected with either greater than 3 ply laminate jacket - less than 0.0000 perm adhesive tape, standard grade, silver, white, black and embossed or PVDC adhesive tape or two coats of vapor retarder coating with a minimum thickness of 1/16 inch and with a 2 inch wide glass tape embedded between coats. Where fitting insulation butts to pipe insulation, the joints shall be sealed with a vapor retarder coating and a 4 inch wide ASJ tape which matches the jacket of the pipe insulation.

d. Anchors attached directly to the pipe shall be insulated for a sufficient distance to prevent condensation but not less than 6 inches from the insulation surface.

e. Insulation shall be marked showing the location of unions, strainers, and check valves.

3.2.2.5 Optional PVC Fitting Covers

At the option of the Contractor, premolded, one or two piece PVC fitting covers may be used in lieu of the vapor retarder and embedded glass tape. Factory precut or premolded insulation segments shall be used under the fitting covers for elbows. Insulation segments shall be the same insulation as the pipe insulation including same density, thickness, and thermal conductivity. The covers shall be secured by PVC vapor retarder tape, adhesive, seal welding or with tacks made for securing PVC covers. Seams in the cover, and tacks and laps to adjoining pipe insulation jacket, shall be sealed with vapor retarder tape to ensure that the assembly has a continuous vapor seal.

3.2.3 Aboveground Hot Pipelines

3.2.3.1 General Requirements

All hot pipe lines above 60 degrees F, except those piping listed in subparagraph Pipe Insulation in PART 3 as to be omitted, shall be insulated in accordance with Table 2. This includes but is not limited to the following:

a. Domestic hot water supply & re-circulating system.

b. Steam.

c. Condensate & compressed air discharge.

d. Hot water heating.

e. Heated oil.

f. Water defrost lines in refrigerated rooms.

Insulation shall be covered, in accordance with manufacturer's recommendations, with a factory applied Type I jacket or field applied aluminum where required or seal welded PVC.

3.2.3.2 Insulation for Fittings and Accessories

Pipe insulation shall be tightly butted to the insulation of the fittings and accessories. The butted joints and ends shall be sealed with joint sealant. Insulation shall be marked showing the location of unions, strainers, check valves and other components that would otherwise be hidden from view by the insulation.

3.2.3.2.1 Precut or Preformed

Place precut or preformed insulation around all fittings and accessories. Insulation shall be the same insulation as the pipe insulation, including same density, thickness, and thermal conductivity.

3.2.3.2.2 Rigid Preformed

Where precut/preformed is unavailable, rigid preformed pipe insulation sections may be segmented into the shape required. Insulation of the same thickness and conductivity as the adjoining pipe insulation shall be used. If nesting size insulation is used, the insulation shall be overlapped 2 inches or one pipe diameter. Elbows insulated using segments shall conform to MICA Tables 12.20 "Mitered Insulation Elbow".

3.2.4 Piping Exposed to Weather

Piping exposed to weather shall be insulated and jacketed as specified for the applicable service inside the building. After this procedure, a laminated self-adhesive (minimum 2 mils adhesive, 3 mils embossed) vapor barrier/weatherproofing jacket - less than 0.0000 permeability (greater than 3 ply, standard grade, silver, white, black and embossed aluminum jacket, stainless steel or PVC jacket shall be applied.

PVC jacketing requires no factory-applied jacket beneath it, however an all service jacket shall be applied if factory applied jacketing is not furnished. Flexible elastomeric cellular insulation exposed to weather shall be treated in accordance with paragraph INSTALLATION OF FLEXIBLE ELASTOMERIC CELLULAR INSULATION in PART 3.

3.2.4.1 Aluminum Jacket

The jacket for hot piping may be factory applied. The jacket shall overlap not less than 2 inches at longitudinal and circumferential joints and shall be secured with bands at not more than 12 inch centers. Longitudinal joints shall be overlapped down to shed water and located at 4 or 8 o'clock positions. Joints on piping 60 degrees F and below shall be sealed with metal jacketing/flashing sealant while overlapping to prevent moisture penetration. Where jacketing on piping 60 degrees F and below abuts an un-insulated surface, joints shall be caulked to prevent moisture penetration. Joints on piping above 60 degrees F shall be sealed with a moisture retarder.

3.2.4.2 Insulation for Fittings

Flanges, unions, valves, fittings, and accessories shall be insulated and finished as specified for the applicable service. Two coats of breather emulsion type weatherproof mastic (impermeable to water, permeable to air) recommended by the insulation manufacturer shall be applied with glass tape embedded between coats. Tape overlaps shall be not less than 1 inch and the adjoining aluminum jacket not less than 2 inches. Factory preformed aluminum jackets may be used in lieu of the above. Molded PVC fitting covers shall be provided when PVC jackets are used for straight runs of pipe. PVC fitting covers shall have adhesive welded joints and shall be weatherproof laminated self-adhesive (minimum 2 mils adhesive, 3 mils embossed) vapor barrier/weatherproofing jacket - less than 0.0000 permeability, (greater than 3 ply, standard grade, silver, white, black and embossed, and UV resistant.

3.2.4.3 PVC Jacket

PVC jacket shall be ultraviolet resistant and adhesive welded weather tight with manufacturer's recommended adhesive. Installation shall include provision for thermal expansion.

3.2.4.4 Stainless Steel Jackets

ASTM A167 or ASTM A240/A240M; Type 304, minimum thickness of 33 gauge (0.010 inch), smooth surface with factory-applied polyethylene and kraft paper moisture barrier on inside surface. Provide stainless steel bands, minimum width of 1/2 inch.

3.2.5 Below Ground Pipe Insulation

Below ground pipes shall be insulated in accordance with Table 2, except as precluded in subparagraph Pipe Insulation in PART 3. This includes, but is not limited to the following:

a. Domestic hot water.

b. Heating hot water.

c. Dual temperature water.

d. Steam.

e. Condensate.

3.2.5.1 Type of Insulation

Below ground pipe shall be insulated with Cellular Glass insulation, in accordance with manufacturer's instructions for application with thickness as determined from Table 2 (whichever is the most restrictive).

3.2.5.2 Installation of Below ground Pipe Insulation

a. Bore surfaces of the insulation shall be coated with a thin coat of gypsum cement of a type recommended by the insulation manufacturer. Coating thickness shall be sufficient to fill surface cells of insulation. Mastic type materials shall not be used for this coating. Note that unless this is for a cyclic application (i.e., one that fluctuates between high and low temperature on a daily process

basis) there is no need to bore coat the material.

b. Stainless steel bands, 3/4 inch wide by 0.020 inch thick shall be used to secure insulation in place. A minimum of two bands per section of insulation shall be applied. As an alternate, fiberglass reinforced tape may be used to secure insulation on piping up to 12 inches in diameter. A minimum of two bands per section of insulation shall be applied.

c. Insulation shall terminate at anchor blocks but shall be continuous through sleeves and manholes.

d. At point of entry to buildings, underground insulation shall be terminated 2 inches inside the wall or floor, shall butt tightly against the aboveground insulation and the butt joint shall be sealed with high temperature silicone sealant and covered with fibrous glass tape.

e. Provision for expansion and contraction of the insulation system shall be made in accordance with the insulation manufacturer's recommendations.

f. Flanges, couplings, valves, and fittings shall be insulated with factory pre-molded, prefabricated, or field-fabricated sections of insulation of the same material and thickness as the adjoining pipe insulation. Insulation sections shall be secured as recommended by the manufacturer.

g. Insulation, including fittings, shall be finished with three coats of asphaltic mastic, with 6 by 5.5 mesh synthetic reinforcing fabric embedded between coats. Fabric shall be overlapped a minimum of 2 inches at joints. Total film thickness shall be a minimum of 3/16 inch. As an alternate, a prefabricated bituminous laminated jacket, reinforced with internal reinforcement mesh, shall be applied to the insulation. Jacketing material and application procedures shall match manufacturer's written instructions. Vapor barrier - less than 0.0000 permeability self adhesive (minimum 2 mils adhesive, 3 mils embossed) jacket greater than 3 ply, standard grade, silver, white, black and embossed or greater than 8 ply (minimum 2.9 mils adhesive), heavy duty, white or natural). Application procedures shall match the manufacturer's written instructions.

h. At termination points, other than building entrances, the mastic and cloth or tape shall cover the ends of insulation and extend 2 inches along the bare pipe.

3.3 DUCT INSULATION SYSTEMS INSTALLATION

Install duct insulation systems in accordance with the approved MICA Insulation Stds plates as supplemented by the manufacturer's published installation instructions. Duct insulation minimum thickness and insulation level must be as listed in Table 3 and must meet or exceed the requirements of ASHRAE 90.1 - IP.

Except for oven hood exhaust duct insulation, corner angles shall be installed on external corners of insulation on ductwork in exposed finished spaces before covering with jacket. Air conditioned spaces shall be defined as those spaces directly supplied with cooled conditioned air (or provided with a cooling device such as a fan-coil unit) and heated

conditioned air (or provided with a heating device such as a unit heater, radiator or convector).

3.3.1 Duct Insulation Minimum Thickness

Duct insulation minimum thickness in accordance with Table 4.

Table 4 - Minimum Duct Insulation (inches)	
Cold Air Ducts	2.0
Relief Ducts	1.5
Fresh Air Intake Ducts	1.5
Warm Air Ducts	2.0
Relief Ducts	1.5
Fresh Air Intake Ducts	1.5

3.3.2 Insulation and Vapor Retarder/Vapor Barrier for Cold Air Duct

Insulation and vapor retarder/vapor barrier shall be provided for the following cold air ducts and associated equipment.

a. Supply ducts.

b. Return air ducts.

c. Relief ducts.

d. Flexible run-outs (field-insulated).

e. Plenums.

f. Duct-mounted coil casings.

g. Coil headers and return bends.

h. Coil casings.

i. Fresh air intake ducts.

j. Filter boxes.

k. Mixing boxes (field-insulated).

l. Supply fans (field-insulated).

m. Site-erected air conditioner casings.

n. Ducts exposed to weather.

o. Combustion air intake ducts.

Insulation for rectangular ducts shall be flexible type where concealed, minimum density 3/4 pcf, and rigid type where exposed, minimum density 3 pcf. Insulation for both concealed or exposed round/oval ducts shall be

flexible type, minimum density 3/4 pcf or a semi rigid board, minimum density 3 pcf, formed or fabricated to a tight fit, edges beveled and joints tightly butted and staggered. Insulation for all exposed ducts shall be provided with either a white, paint-able, factory-applied Type I jacket or a field applied vapor retarder/vapor barrier jacket coating finish as specified, the total field applied dry film thickness shall be approximately 1/16 inch. Insulation on all concealed duct shall be provided with a factory-applied Type I or II vapor retarder/vapor barrier jacket. Duct insulation shall be continuous through sleeves and prepared openings except firewall penetrations. Duct insulation terminating at fire dampers, shall be continuous over the damper collar and retaining angle of fire dampers, which are exposed to unconditioned air and which may be prone to condensate formation. Duct insulation and vapor retarder/vapor barrier shall cover the collar, neck, and any un-insulated surfaces of diffusers, registers and grills. Vapor retarder/vapor barrier materials shall be applied to form a complete unbroken vapor seal over the insulation. Sheet Metal Duct shall be sealed in accordance with Section 23 00 00 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM.

3.3.2.1 Installation on Concealed Duct

a. For rectangular, oval or round ducts, flexible insulation shall be attached by applying adhesive around the entire perimeter of the duct in 6 inch wide strips on 12 inch centers.

b. For rectangular and oval ducts, 24 inches and larger insulation shall be additionally secured to bottom of ducts by the use of mechanical fasteners. Fasteners shall be spaced on 16 inch centers and not more than 16 inches from duct corners.

c. For rectangular, oval and round ducts, mechanical fasteners shall be provided on sides of duct risers for all duct sizes. Fasteners shall be spaced on 16 inch centers and not more than 16 inches from duct corners.

d. Insulation shall be impaled on the mechanical fasteners (self stick pins) where used and shall be pressed thoroughly into the adhesive. Care shall be taken to ensure vapor retarder/vapor barrier jacket joints overlap 2 inches. The insulation shall not be compressed to a thickness less than that specified. Insulation shall be carried over standing seams and trapeze-type duct hangers.

e. Where mechanical fasteners are used, self-locking washers shall be installed and the pin trimmed and bent over.

f. Jacket overlaps shall be secured with staples and tape as necessary to ensure a secure seal. Staples, tape and seams shall be coated with a brush coat of vapor retarder coating or PVDC adhesive tape or greater than 3 ply laminate (minimum 2 mils adhesive, 3 mils embossed) - less than 0.0000 perm adhesive tape.

g. Breaks in the jacket material shall be covered with patches of the same material as the vapor retarder jacket. The patches shall extend not less than 2 inches beyond the break or penetration in all directions and shall be secured with tape and staples. Staples and tape joints shall be sealed with a brush coat of vapor retarder coating or PVDC adhesive tape or greater than 3 ply laminate (minimum 2 mils adhesive, 3 mils embossed) - less than 0.0000 perm adhesive tape.

h. Ductwork insulation must be continuous through duct hangers. Duct hangers are not permitted to penetrate duct insulation.

~~h~~ i. At jacket penetrations such as ~~hangers,~~ thermometers, and damper operating rods, voids in the insulation shall be filled and the penetration sealed with a brush coat of vapor retarder coating or PVDC adhesive tape greater than 3 ply laminate (minimum 2 mils adhesive, 3 mils embossed) - less than 0.0000 perm adhesive tape.

j~~i~~. Insulation terminations and pin punctures shall be sealed and flashed with a reinforced vapor retarder coating finish or tape with a brush coat of vapor retarder coating.. The coating shall overlap the adjoining insulation and un-insulated surface 2 inches. Pin puncture coatings shall extend 2 inches from the puncture in all directions.

k~~j~~. Where insulation standoff brackets occur, insulation shall be extended under the bracket and the jacket terminated at the bracket.

3.3.2.2 Installation on Exposed Duct Work

a. For rectangular ducts, rigid insulation shall be secured to the duct by mechanical fasteners on all four sides of the duct, spaced not more than 12 inches apart and not more than 3 inches from the edges of the insulation joints. A minimum of two rows of fasteners shall be provided for each side of duct 12 inches and larger. One row shall be provided for each side of duct less than 12 inches. Mechanical fasteners shall be as corrosion resistant as G60 coated galvanized steel, and shall indefinitely sustain a 50 lb tensile dead load test perpendicular to the duct wall.

b. Form duct insulation with minimum jacket seams. Fasten each piece of rigid insulation to the duct using mechanical fasteners. When the height of projections is less than the insulation thickness, insulation shall be brought up to standing seams, reinforcing, and other vertical projections and shall not be carried over. Vapor retarder/barrier jacket shall be continuous across seams, reinforcing, and projections. When height of projections is greater than the insulation thickness, insulation and jacket shall be carried over. Apply insulation with joints tightly butted. Neatly bevel insulation around name plates and access plates and doors.

c. Impale insulation on the fasteners; self-locking washers shall be installed and the pin trimmed and bent over.

d. Seal joints in the insulation jacket with a 4 inch wide strip of tape. Seal taped seams with a brush coat of vapor retarder coating.

e. Breaks and ribs or standing seam penetrations in the jacket material shall be covered with a patch of the same material as the jacket. Patches shall extend not less than 2 inches beyond the break or penetration and shall be secured with tape and stapled. Staples and joints shall be sealed with a brush coat of vapor retarder coating.

f. Ductwork insulation must be continuous through duct hangers. Duct hangers are not permitted to penetrate duct insulation.

~~f~~ g. At jacket penetrations such as ~~hangers,~~ thermometers, and damper operating rods, the voids in the insulation shall be filled and the

penetrations sealed with a flashing sealant.

~~g~~h. Insulation terminations and pin punctures shall be sealed and flashed with a reinforced vapor retarder coating finish. The coating shall overlap the adjoining insulation and un-insulated surface 2 inches. Pin puncture coatings shall extend 2 inches from the puncture in all directions.

~~h~~i. Oval and round ducts, flexible type, shall be insulated with factory Type I jacket insulation with minimum density of 3/4 pcf, attached as in accordance with MICA standards.

3.3.3 Insulation for Warm Air Duct

Insulation and vapor barrier shall be provided for the following warm air ducts and associated equipment:.

a. Supply ducts.

b. Return air ducts.

c. Relief air ducts

d. Flexible run-outs (field insulated).

e. Plenums.

f. Duct-mounted coil casings.

g. Coil-headers and return bends.

h. Coil casings.

i. Fresh air intake ducts.

j. Filter boxes.

k. Mixing boxes.

l. Supply fans.

m. Site-erected air conditioner casings.

n. Ducts exposed to weather.

o. Exhaust ducts passing through concealed spaces exhausting conditioned air.

Insulation for rectangular ducts shall be flexible type where concealed, and rigid type where exposed. Insulation on exposed ducts shall be provided with a white, paint-able, factory-applied Type II jacket, or finished with adhesive finish. Flexible type insulation shall be used for round ducts, with a factory-applied Type II jacket. Insulation on concealed duct shall be provided with a factory-applied Type II jacket. Adhesive finish where indicated to be used shall be accomplished by applying two coats of adhesive with a layer of glass cloth embedded between the coats. The total dry film thickness shall be approximately 1/16 inch. Duct insulation shall be continuous through sleeves and prepared openings. Duct insulation shall terminate at fire dampers and

flexible connections.

3.3.3.1 Installation on Concealed Duct

a. For rectangular, oval and round ducts, insulation shall be attached by applying adhesive around the entire perimeter of the duct in 6 inch wide strips on 12 inch centers.

b. For rectangular and oval ducts 24 inches and larger, insulation shall be secured to the bottom of ducts by the use of mechanical fasteners. Fasteners shall be spaced on 18 inch centers and not more than 18 inches from duct corner.

c. For rectangular, oval and round ducts, mechanical fasteners shall be provided on sides of duct risers for all duct sizes. Fasteners shall be spaced on 18 inch centers and not more than 18 inches from duct corners.

d. The insulation shall be impaled on the mechanical fasteners where used. The insulation shall not be compressed to a thickness less than that specified. Insulation shall be carried over standing seams and trapeze-type hangers.

e. Self-locking washers shall be installed where mechanical fasteners are used and the pin trimmed and bent over.

f. Insulation jacket shall overlap not less than 2 inches at joints and the lap shall be secured and stapled on 4 inch centers.

3.3.3.2 Installation on Exposed Duct

a. For rectangular ducts, the rigid insulation shall be secured to the duct by the use of mechanical fasteners on all four sides of the duct, spaced not more than 16 inches apart and not more than 6 inches from the edges of the insulation joints. A minimum of two rows of fasteners shall be provided for each side of duct 12 inches and larger and a minimum of one row for each side of duct less than 12 inches.

b. Duct insulation with factory-applied jacket shall be formed with minimum jacket seams, and each piece of rigid insulation shall be fastened to the duct using mechanical fasteners. When the height of projection is less than the insulation thickness, insulation shall be brought up to standing seams, reinforcing, and other vertical projections and shall not be carried over the projection. Jacket shall be continuous across seams, reinforcing, and projections. Where the height of projections is greater than the insulation thickness, insulation and jacket shall be carried over the projection.

c. Insulation shall be impaled on the fasteners; self-locking washers shall be installed and pin trimmed and bent over.

d. Joints on jacketed insulation shall be sealed with a 4 inch wide strip of tape and brushed with vapor retarder coating.

e. Breaks and penetrations in the jacket material shall be covered with a patch of the same material as the jacket. Patches shall extend not less than 2 inches beyond the break or penetration and shall be secured with adhesive and stapled.

f. Insulation terminations and pin punctures shall be sealed with tape and brushed with vapor retarder coating.

g. Oval and round ducts, flexible type, shall be insulated with factory Type I jacket insulation, minimum density of 3/4 pcf attached by staples spaced not more than 16 inches and not more than 6 inches from the degrees of joints. Joints shall be sealed in accordance with item "d." above.

3.3.4 Duct Test Holes

After duct systems have been tested, adjusted, and balanced, breaks in the insulation and jacket shall be repaired in accordance with the applicable section of this specification for the type of duct insulation to be repaired.

3.3.5 Duct Exposed to Weather

3.3.5.1 Installation

Ducts exposed to weather shall be insulated and finished as specified for the applicable service for exposed duct inside the building. After the above is accomplished, the insulation shall then be further finished as detailed in the following subparagraphs.

3.3.5.2 Round Duct

Laminated self-adhesive (minimum 2 mils adhesive, 3 mils embossed) vapor barrier/weatherproofing jacket - Less than 0.0000 permeability, (greater than 3 ply, standard grade, silver, white, black and embossed or greater than 8 ply, heavy duty, white and natural) membrane shall be applied overlapping material by 3 inches no bands or caulking needed - see manufacturer's recommended installation instructions. Aluminum jacket with factory applied moisture retarder shall be applied with the joints lapped not less than 3 inches and secured with bands located at circumferential laps and at not more than 12 inch intervals throughout. Horizontal joints shall lap down to shed water and located at 4 or 8 o'clock position. Joints shall be sealed with metal jacketing sealant to prevent moisture penetration. Where jacketing abuts an un-insulated surface, joints shall be sealed with metal jacketing sealant.

3.3.5.3 Fittings

Fittings and other irregular shapes shall be finished as specified for rectangular ducts.

3.3.5.4 Rectangular Ducts

Two coats of weather barrier mastic reinforced with fabric or mesh for outdoor application shall be applied to the entire surface. Each coat of weatherproof mastic shall be 1/16 inch minimum thickness. The exterior shall be a metal jacketing applied for mechanical abuse and weather protection, and secured with screws or vapor barrier/weatherproofing jacket less than 0.0000 permeability greater than 3 ply, standard grade, silver, white, black, and embossed or greater than 8 ply, heavy duty white and natural. Membrane shall be applied overlapping material by 3 inches. No bands or caulking needed-see manufacturing recommend installation instructions.

3.4 ACOUSTICAL BARRIER WRAP INSTALLATION

Provide where shown or specified. Completely cover area indicated. Place absorptive backing material against surface being treated to decouple outer limp barrier material from metal.

Seal all joints with minimum 2-inch overlap of limp barrier material similar to that used in construction to form continuous airtight barrier around surface being treated. Seal all joints where barrier wrap abuts building construction with acoustical sealant.

Adhere with 100% coverage of adhesive. Adhere wrapping treatment to surface and also mechanically fasten by impaling absorptive backing and barrier material on stick pins or weld nail pins.

3.5 EQUIPMENT INSULATION SYSTEMS INSTALLATION

Install equipment insulation systems in accordance with the approved MICA Insulation Stds plates as supplemented by the manufacturer's published installation instructions.

3.5.1 General

Removable insulation sections shall be provided to cover parts of equipment that must be opened periodically for maintenance including vessel covers, fasteners, flanges and accessories. Equipment insulation shall be omitted on the following:

a. Hand-holes.

b. Boiler manholes.

c. Cleanouts.

d. ASME stamps.

e. Manufacturer's nameplates.

f. Duct Test/Balance Test Holes.

3.5.2 Insulation for Cold Equipment

Cold equipment below 60 degrees F: Insulation shall be furnished on equipment handling media below 60 degrees F including the following:

a. Pumps.

b. Refrigeration equipment parts that are not factory insulated.

c. Drip pans under chilled equipment.

d. Cold water storage tanks.

e. Water softeners.

f. Duct mounted coils.

g. Cold and chilled water pumps.

h. Roof drain bodies.

i. Air handling equipment parts that are not factory insulated.

j. Expansion and air separation tanks.

3.5.2.1 Insulation Type

Insulation shall be suitable for the temperature encountered. Material and thicknesses shall be as shown in Table 5:

TABLE 5

Insulation Thickness for Cold Equipment (inches)

Equipment handling media at indicated temperature		
	Material	Thickness (inches)
35 to 60 degrees F		
	Cellular Glass	1.5
	Flexible Elastomeric Cellular	1
1 to 34 degrees F		
	Cellular Glass	3
	Flexible Elastomeric Cellular	1.5
Minus 30 to 0 degrees F		
	Cellular Glass	3.5
	Flexible Elastomeric Cellular	1.75

3.5.2.2 Pump Insulation

a. Insulate pumps by forming a box around the pump housing. The box shall be constructed by forming the bottom and sides using joints that do not leave raw ends of insulation exposed. Joints between sides and between sides and bottom shall be joined by adhesive with lap strips for rigid mineral fiber and contact adhesive for flexible elastomeric cellular insulation. The box shall conform to the requirements of MICA Insulation Stds plate No. 49 when using flexible elastomeric cellular insulation. Joints between top cover and sides shall fit tightly forming a female shiplap joint on the side pieces and a male joint on the top cover, thus making the top cover removable.

b. Exposed insulation corners shall be protected with corner angles.

c. Upon completion of installation of the insulation, including removable sections, two coats of vapor retarder coating shall be applied with a layer of glass cloth embedded between the coats. The total dry thickness of the finish shall be 1/16 inch. A parting line shall be

provided between the box and the removable sections allowing the removable sections to be removed without disturbing the insulation coating. Flashing sealant shall be applied to parting line, between equipment and removable section insulation, and at all penetrations.

3.5.2.3 Other Equipment

a. Insulation shall be formed or fabricated to fit the equipment. To ensure a tight fit on round equipment, edges shall be beveled and joints shall be tightly butted and staggered.

b. Insulation shall be secured in place with bands or wires at intervals as recommended by the manufacturer but not more than 12 inch centers except flexible elastomeric cellular which shall be adhered with contact adhesive. Insulation corners shall be protected under wires and bands with suitable corner angles.

c. Cellular glass shall be installed in accordance with manufacturer's instructions. Joints and ends shall be sealed with joint sealant, and sealed with a vapor retarder coating.

d. Insulation on heads of heat exchangers shall be removable. Removable section joints shall be fabricated using a male-female shiplap type joint. The entire surface of the removable section shall be finished by applying two coats of vapor retarder coating with a layer of glass cloth embedded between the coats. The total dry thickness of the finish shall be 1/16 inch.

e. Exposed insulation corners shall be protected with corner angles.

f. Insulation on equipment with ribs shall be applied over 6 by 6 inches by 12 gauge welded wire fabric which has been cinched in place, or if approved by the Contracting Officer, spot welded to the equipment over the ribs. Insulation shall be secured to the fabric with J-hooks and 2 by 2 inches washers or shall be securely banded or wired in place on 12 inch centers.

3.5.2.4 Vapor Retarder/Vapor Barrier

Upon completion of installation of insulation, penetrations shall be caulked. Two coats of vapor retarder coating or vapor barrier jacket shall be applied over insulation, including removable sections, with a layer of open mesh synthetic fabric embedded between the coats. The total dry thickness of the finish shall be 1/16 inch. Flashing sealant or vapor barrier tape shall be applied to parting line between equipment and removable section insulation.

3.5.3 Insulation for Hot Equipment

Insulation shall be furnished on equipment handling media above 60 degrees F including the following:

a. Converters.

b. Heat exchangers.

c. Hot water generators.

d. Water heaters.

e. Pumps handling media above 130 degrees F.

f. Hot water storage tanks.

g. Air separation tanks.

h. Surge tanks.

i. Flash tanks.

j. Feed-water heaters.

k. Unjacketed boilers or parts of boilers.

l. Boiler flue gas connection from boiler to stack (if inside).

m. Induced draft fans.

n. Condensate receivers.

3.5.3.1 Insulation

Insulation shall be suitable for the temperature encountered. Shell and tube-type heat exchangers shall be insulated for the temperature of the shell medium.

Insulation thickness for hot equipment shall be determined using Table 6:

TABLE 6

Insulation Thickness for Hot Equipment (inches)

Equipment handling steam or media at indicated pressure or temperature limit		
	Material	Thickness (inches)
15 psig or 250 degrees F		
	Rigid Mineral Fiber	2
	Flexible Mineral Fiber	2
	Calcium Silicate/Perlite	4
	Cellular Glass	3
	Faced Phenolic Foam	1.5
	Flexible Elastomeric Cellular (<200 F)	1
200psig or 400 degrees F		
	Rigid Mineral Fiber	3
	Flexible Mineral Fiber	3
	Calcium Silicate/Perlite	4

TABLE 6		
Insulation Thickness for Hot Equipment (inches)		
Equipment handling steam or media at indicated pressure or temperature limit		
	Material	Thickness (inches)
	Cellular Glass	4
600 degrees F		
	Rigid Mineral Fiber	5
	Flexible Mineral Fiber	6
	Calcium Silicate/Perlite	6
	Cellular Glass	6
600 degrees F: Thickness necessary to limit the external temperature of the insulation to 120 F. Heat transfer calculations shall be submitted to substantiate insulation and thickness selection.		

3.5.3.2 Insulation of Pumps

Insulate pumps by forming a box around the pump housing. The box shall be constructed by forming the bottom and sides using joints that do not leave raw ends of insulation exposed. Bottom and sides shall be banded to form a rigid housing that does not rest on the pump. Joints between top cover and sides shall fit tightly. The top cover shall have a joint forming a female shiplap joint on the side pieces and a male joint on the top cover, making the top cover removable. Two coats of Class I adhesive shall be applied over insulation, including removable sections, with a layer of glass cloth embedded between the coats. A parting line shall be provided between the box and the removable sections allowing the removable sections to be removed without disturbing the insulation coating. The total dry thickness of the finish shall be 1/16 inch. Caulking shall be applied to parting line of the removable sections and penetrations.

3.5.3.3 Other Equipment

a. Insulation shall be formed or fabricated to fit the equipment. To ensure a tight fit on round equipment, edges shall be beveled and joints shall be tightly butted and staggered.

b. Insulation shall be secured in place with bands or wires at intervals as recommended by the manufacturer but not greater than 12 inch centers except flexible elastomeric cellular which shall be adhered. Insulation corners shall be protected under wires and bands with suitable corner angles.

c. On high vibration equipment, cellular glass insulation shall be set in a coating of bedding compound as recommended by the manufacturer, and joints shall be sealed with bedding compound. Mineral fiber joints shall be filled with finishing cement.

d. Insulation on heads of heat exchangers shall be removable. The

removable section joint shall be fabricated using a male-female shiplap type joint. Entire surface of the removable section shall be finished as specified.

e. Exposed insulation corners shall be protected with corner angles.

f. On equipment with ribs, such as boiler flue gas connection, draft fans, and fly ash or soot collectors, insulation shall be applied over 6 by 6 inch by 12 gauge welded wire fabric which has been cinched in place, or if approved by the Contracting Officer, spot welded to the equipment over the ribs. Insulation shall be secured to the fabric with J-hooks and 2 by 2 inch washers or shall be securely banded or wired in place on 12 inch (maximum) centers.

g. On equipment handling media above 600 degrees F, insulation shall be applied in two or more layers with joints staggered.

h. Upon completion of installation of insulation, penetrations shall be caulked. Two coats of adhesive shall be applied over insulation, including removable sections, with a layer of glass cloth embedded between the coats. The total dry thickness of the finish shall be 1/16 inch. Caulking shall be applied to parting line between equipment and removable section insulation.

3.5.4 Equipment Exposed to Weather

3.5.4.1 Installation

Equipment exposed to weather shall be insulated and finished in accordance with the requirements for ducts exposed to weather in paragraph DUCT INSULATION INSTALLATION.

3.5.4.2 Optional Panels

At the option of the Contractor, prefabricated metal insulation panels may be used in lieu of the insulation and finish previously specified. Thermal performance shall be equal to or better than that specified for field applied insulation. Panels shall be the standard catalog product of a manufacturer of metal insulation panels. Fastenings, flashing, and support system shall conform to published recommendations of the manufacturer for weatherproof installation and shall prevent moisture from entering the insulation. Panels shall be designed to accommodate thermal expansion and to support a 250 pound walking load without permanent deformation or permanent damage to the insulation. Exterior metal cover sheet shall be aluminum and exposed fastenings shall be stainless steel or aluminum.

-- End of Section --

SECTION 23 09 00

INSTRUMENTATION AND CONTROL FOR HVAC
02/19

PART 1 GENERAL

1.1 SUMMARY

Provide a complete Direct Digital Control (DDC) system, except for the Front End which is specified in Section 25 10 10 UTILITY MONITORING AND CONTROL (UMCS) FRONT END AND INTEGRATION, suitable for the control of the heating, ventilating and air conditioning (HVAC) and other building-level systems as indicated and shown and in accordance with Section 23 09 13 INSTRUMENTATION AND CONTROL DEVICES FOR HVAC, Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS for LNS LonWorks systems or Niagara LonWorks systems, and other referenced Sections.

1.1.1 System Requirements

Provide systems meeting the requirements this Section and other Sections referenced by this Section, and which have the following characteristics:

a. The system implements the control sequences of operation shown in the Contract Drawings using DDC hardware to control mechanical and electrical equipment

b. The system meet the requirements of this specification as a stand-alone system and does not require connection to any other system.

c. Control sequences reside in DDC hardware in the building. The building control network is not dependent upon connection to a Utility Monitoring and Control System (UMCS) Front End or to any other system for performance of control sequences. To the greatest extent practical, the hardware performs control sequences without reliance on the building network, unless otherwise pre-approved by the Contracting Officer.

d. The hardware is installed such that individual control equipment can be replaced by similar control equipment from other equipment manufacturers with no loss of system functionality.

e. All necessary documentation, configuration information, programming tools, programs, drivers, and other software are licensed to and otherwise remain with the Government such that the Government or their agents are able to perform repair, replacement, upgrades, and expansions of the system without subsequent or future dependence on the Contractor, Vendor or Manufacturer.

f. Sufficient documentation and data, including rights to documentation and data, are provided such that the Government or their agents can execute work to perform repair, replacement, upgrades, and expansions of the system without subsequent or future dependence on the Contractor, Vendor or Manufacturer.

g. Hardware is installed and configured such that the Government or their

agents are able to perform repair, replacement, and upgrades of individual hardware without further interaction with the Contractor, Vendor or Manufacturer.

h. All Niagara Framework components have an unrestricted interoperability license with a Niagara Compatibility Statement (NiCS) following the Tridium Open NiCS Specification and have a value of "ALL" for "Station Compatibility In", "Station Compatibility Out", "Tool Compatibility In" and "Tool Compatibility Out". Note that this will result in the following entries in the license file:
    accept.station.in="*"
    accept.station.out="*"
    accept.wb.in="*"
    accept.wb.out="*"

1.1.2 End to End Accuracy

Select products, install and configure the system such that the maximum error of a measured value as read from the DDC Hardware over the network is less than the maximum allowable error specified for the sensor or instrumentation.

1.1.3 Verification of Dimensions

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

1.1.4 Drawings

The Government will not indicate all offsets, fittings, and accessories that may be required on the drawings. Carefully investigate the mechanical, electrical, and finish conditions that could affect the work to be performed, arrange such work accordingly, and provide all work necessary to meet such conditions.

1.2 RELATED SECTIONS

Related work specified elsewhere:

a. Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS for LonWorks Systems using LNS or Niagara Framework.

b. Section 23 09 13 INSTRUMENTATION AND CONTROL DEVICES FOR HVAC

c. Section 25 10 10 UTILITY MONITORING AND CONTROL SYSTEMS (UMCS) FRONT END AND INTEGRATION

d. Section 25 05 11.21 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS

e. Section 01 91 00.15 10 TOTAL BUILDING COMMISSIONING

1.3 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE FUN IP	(2017) Fundamentals Handbook, I-P Edition

CONSUMER ELECTRONICS ASSOCIATION (CEA)

CEA-709.1-D	(2014) Control Network Protocol Specification
CEA-709.3	(1999; R 2015) Free-Topology Twisted-Pair Channel Specification

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41	(1991; R 1995) Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2018) Enclosures for Electrical Equipment (1000 Volts Maximum)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2020; ERTA 20-1 2020; ERTA 20-2 2020; TIA 20-1; TIA 20-2; TIA 20-3; TIA 20-4) National Electrical Code
NFPA 90A	(2018) Standard for the Installation of Air Conditioning and Ventilating Systems

~~TRIDIUM, INC (TRIDIUM)~~

~~Niagara Framework~~	~~(2012) NiagaraAX User's Guide~~
~~Tridium Open NiCS~~	~~(2005) Understanding the NiagaraAX Compatibility Statement (NiCS)~~

UNDERWRITERS LABORATORIES (UL)

UL 5085-3	(2006; Reprint Nov 20121) Low Voltage Transformers - Part 3: Class 2 and Class 3 Transformers

1.4 DEFINITIONS

The following list of definitions includes terms used in Sections referenced by this Section and are included here for completeness.The definitions contained in this Section may disagree with how terms are defined or used in other documents, including documents referenced by this Section. The definitions included here are the authoritative definitions for this Section and all Sections referenced by this Section.

After each term the protocol related to that term is included in parenthesis.

1.4.1 Alarm Generation (All protocols)

Alarm Generation is the monitoring of a value, comparison of the value to alarm conditions and the creation of an alarm when the conditions set for the alarm are met. Note that this does NOT include delivery of the alarm to the final destination (such as a user interface) - see paragraph ALARM ROUTING in Section 25 10 10 UTILITY MONITORING AND CONTROL SYSTEM (UMCS) FRONT END AND INTEGRATION.

1.4.2 Application Generic Controller (AGC) (LonWorks)

A device that is furnished with a (limited) pre-established application that also has the capability of being programmed. Further, the ProgramID and XIF file of the device are fixed. The programming capability of an AGC may be less flexible than that of a General Purpose Programmable Controller (GPPC).

1.4.3 Application Specific Controller (ASC) (LonWorks)

A device that is furnished with a pre-established built in application that is configurable but not re-programmable. An ASC has a fixed factory-installed application program (i.e Program ID) with configurable settings.

1.4.4 Binary (All protocols)

A two-state system where an "ON" condition is represented by a high signal level and an "OFF" condition is represented by a low signal level. 'Digital' is sometimes used interchangeably with 'binary'.

1.4.5 Binding (LonWorks)

The act of establishing communications between CEA-709.1-D devices by associating the output of a device to the input of another so that information is automatically (and regularly) sent.

1.4.6 Building Control Network (BCN) (All protocols)

The network connecting all DDC Hardware within a building (or specific group of buildings).

1.4.7 Building Point of Connection (BPOC) (All protocols)

A FPOC for a Building Control System. (This term is being phased out of use in preference for FPOC but is still used in some specifications and criteria. When it was used, it typically referred to a piece of control hardware. The current FPOC definition typically refers instead to IT hardware.)

1.4.8 Channel (LonWorks)

A portion of the control network consisting of one or more segments connected by repeaters. Channels are separated by routers. The device quantity limitation is dependent on the topology/media and device type. For example, a TP/FT-10 network with locally powered devices is limited to 128 devices per channel.

1.4.9 Commandable (All protocols)

See Overridable.

1.4.10 Configurable (All protocols)

A property, setting, or value is configurable if it can be changed via hardware settings on the device, via the use of engineering software or over the control network from the front end, and is retained through (after) loss of power.

1.4.11 Configuration Property (LonWorks)

Controller parameter used by the application which is usually set during installation/testing and seldom changed. For example, the P and I settings of a P-I control loop. Also see paragraph STANDARD CONFIGURATION PROPERTY TYPE (SCPT).

1.4.12 Control Logic Diagram (All protocols)

A graphical representation of control logic for multiple processes that make up a system.

1.4.13 Digital Controller (All protocols)

An electronic controller, usually with internal programming logic and digital and analog input/output capability, which performs control functions.

1.4.14 Direct Digital Control (DDC) (All protocols)

Digital controllers performing control logic. Usually the controller directly senses physical values, makes control decisions with internal programs, and outputs control signals to directly operate switches, valves, dampers, and motor controllers.

1.4.15 Domain (LonWorks)

A grouping of up to 32,385 nodes that can communicate directly with each other. (Devices in different domains cannot communicate directly with each other.) See also Node Address.

1.4.16 Explicit Messaging (LonWorks)

A non-standard and often vendor (application) specific method of communication between devices where each message contains a message code that identifies the type of message and the devices use these codes to determine the action to take when the message is received.

1.4.17 External Interface File (XIF) (LonWorks)

A file which documents a device's external interface, specifically the number and types of LonMark objects, the number, types, directions, and connection attributes of network variables, and the number of message tags.

1.4.18 Field Point of Connection (FPOC) (All protocols)

The FPOC is the point of connection between the UMCS IP Network and the field control network (either an IP network, a non-IP network, or a

combination of both). The hardware at this location which provides the connection is generally an IT device such as a switch, IP router, or firewall.

In general, the term "FPOC Location" means the place where this connection occurs, and "FPOC Hardware" means the device that provides the connection. Sometimes the term "FPOC" is used to mean either and its actual meaning (i.e. location or hardware) is determined by the context in which it is used.

1.4.19 Fox Protocol (Niagara Framework)

The protocol used for communication between components in the Niagara Framework. By default, Fox uses TCP port 1911.

1.4.20 Functional Profile (LonWorks)

A standard description, defined by LonMark, of one or more LonMark Objects used to classify and certify devices.

1.4.21 Gateway (All protocols)

A device that translates from one protocol application data format to another. Devices that change only the transport mechanism of the protocol - "translating" from TP/FT-10 to Ethernet/IP or from BACnet MS/TP to BACnet over IP for example - are not gateways as the underlying data format does not change. Gateways are also called Communications Bridges or Protocol Translators.

A Niagara Framework Supervisory Gateway is one type of Gateway.

1.4.22 General Purpose Programmable Controller (GPPC) (LonWorks)

Unlike an ASC or AGC, a GPPC is not furnished with a fixed application program and does not have a fixed ProgramID or XIF file. A GPPC can be (re-)programmed, usually using vendor-supplied software. When a change to the program affects the external interface (and the XIF file) the ProgramID will change.

1.4.23 IEEE 802.3 Ethernet (All protocols)

A family of local-area-network technologies providing high-speed networking features over various media, typically Cat 5, 5e or Cat 6 twisted pair copper or fiber optic cable.

1.4.24 Internet Protocol (IP, TCP/IP, UDP/IP) (All protocols)

A communication method, the most common use is the World Wide Web. At the lowest level, it is based on Internet Protocol (IP), a method for conveying and routing packets of information over various LAN media. Two common protocols using IP are User Datagram Protocol (UDP) and Transmission Control Protocol (TCP). UDP conveys information to well-known "sockets" without confirmation of receipt. TCP establishes connections, also known as "sessions", which have end-to-end confirmation and guaranteed sequence of delivery.

1.4.25 Input/Output (I/O) (All protocols)

Physical inputs and outputs to and from a device, although the term

sometimes describes network or "virtual" inputs or outputs. See also "Points".

1.4.26 I/O Expansion Unit (All protocols)

An I/O expansion unit provides additional point capacity to a digital controller

1.4.27 IP subnet (All protocols)

A group of devices which share a defined range IP addresses. Devices on a common IP subnet can share data (including broadcasts) directly without the need for the traffic to traverse an IP router.

1.4.28 JACE (Niagara Framework)

Java Application Control Engine. See paragraph NIAGARA FRAMEWORK SUPERVISORY GATEWAY

1.4.29 Local-Area Network (LAN) (All protocols)

A communication network that spans a limited geographic area and uses the same basic communication technology throughout.

1.4.30 Local Display Panels (LDPs) (All protocols)

A DDC Hardware with a display and navigation buttons, and must provide display and adjustment of points as shown on the Points Schedule and as indicated.

1.4.31 LonMark (LonWorks)

See paragraph LONMARK INTERNATIONAL. Also, a certification issued by LonMark International to CEA-709.1-D devices.

1.4.32 LonMark International (LonWorks)

Standards committee consisting of numerous independent product developers, system integrators and end users dedicated to determining and maintaining the interoperability guidelines for LonWorks. Maintains guidelines for the interoperability of CEA-709.1-D devices and issues the LonMark Certification for CEA-709.1-D devices.

1.4.33 LonMark Interoperability Association (LonWorks)

See paragraph LONMARK INTERNATIONAL.

1.4.34 LonMark Object (LonWorks)

A collection of network variables, configuration properties, and associated behavior defined by LonMark International and described by a Functional Profile. It defines how information is exchanged between devices on a network (inputs from and outputs to the network).

1.4.35 LonWorks (LonWorks)

The term used to refer to the overall technology related to the CEA-709.1-D protocol (sometimes called "LonTalk"), including the protocol itself, network management, interoperability guidelines and products.

1.4.36 LonWorks Network Services (LNS) (LonWorks)

A network management and database standard for CEA-709.1-D devices.

1.4.37 MAC Address (All protocols)

Media Access Control address. The physical device address that identifies a device on a Local Area Network.

1.4.38 Monitoring and Control (M&C) Software (All protocols)

The UMCS 'front end' software which performs supervisory functions such as alarm handling, scheduling and data logging and provides a user interface for monitoring the system and configuring these functions.

1.4.39 Network Variable (LonWorks)

See paragraph STANDARD NETWORK VARIABLE TYPE (SNVT).

1.4.40 Network Configuration Tool (LonWorks)

The software used to configure the control network and set device configuration properties. This software creates and modifies the control network database.

1.4.41 Niagara Framework (Niagara Framework)

A set of hardware and software specifications for building and utility control owned by Tridium Inc. and licensed to multiple vendors. The Framework consists of front end (M&C) software, web based clients, field level control hardware, and engineering tools. While the Niagara Framework is not adopted by a recognized standards body and does not use an open licensing model, it is sufficiently well-supported by multiple HVAC vendors to be considered a de-facto Open Standard.

1.4.42 Niagara Framework Supervisory Gateway (Niagara Framework)

DDC Hardware component of the Niagara Framework. A typical Niagara architecture has Niagara specific supervisory gateways at the IP level and other (non-Niagara specific) controllers on field networks (TP/FT-10, MS/TP, etc.) beneath the Niagara supervisory gateways. The Niagara specific controllers function as a gateway between the Niagara framework protocol (Fox) and the field network beneath. These supervisory gateways may also be used as general purpose controllers and also have the capability to provide a web-based user interface.

Note that different vendors refer to this component by different names. The most common name is "JACE"; other names include (but are not limited to)"EC-BOS", "FX-40", "TMN", "SLX" and "UNC".

1.4.43 Node (LonWorks)

A device that communicates using the CEA-709.1-D protocol and is connected to a CEA-709.1-D network.

1.4.44 Node Address (LonWorks)

The logical address of a node on the network, consisting of a Domain

number, Subnet number and Node number. Note that the "Node number" portion of the address is the number assigned to the device during installation and is unique within a subnet. This is not the factory-set unique Node ID (see Node ID).

1.4.45 Node ID (LonWorks)

A unique 48-bit identifier assigned (at the factory) to each CEA-709.1-D device. Sometimes called the Neuron ID.

1.4.46 Operator Configurable (All protocols)

Operator configurable values are values that can be changed from a single common front end user interface across multiple vendor systems.

For Niagara Framework Systems, a property, setting, or value is Operator Configurable when it is configurable from a Niagara Framework Front End.

1.4.47 Override (All protocols)

Changing the value of a point outside of the normal sequence of operation where the change has priority over the sequence and where there is a mechanism for releasing the change such that the point returns to the normal value. Overrides persist until released or overridden at the same or higher priority but are not required to persist through a loss of power. Overrides are often used by operators to change values, and generally originate at a user interface (workstation or local display panel).

1.4.48 Packaged Equipment (All protocols)

Packaged equipment is a single piece of equipment provided by a manufacturer in a substantially complete and operable condition, where the controls (DDC Hardware) are factory installed, and the equipment is sold and shipped from the manufacturer as a single entity. Disassembly and reassembly of a large piece of equipment for shipping does not prevent it from being packaged equipment. Package units may require field installation of remote sensors. Packaged equipment is also called a "packaged unit".

Note industry may use the term "Packaged System" to mean a collection of equipment that is designed to work together where each piece of equipment is packaged equipment and there is a network that connects the equipment together. A "packaged system" of this type is NOT packaged equipment; it is a collection of packaged equipment, and each piece of equipment must individually meet specification requirements.

1.4.49 Packaged Unit (All protocols)

See packaged equipment.

1.4.50 Performance Verification Test (PVT) (All protocols)

The procedure for determining if the installed BAS meets design criteria prior to final acceptance. The PVT is performed after installation, testing, and balancing of mechanical systems. Typically the PVT is performed by the Contractor in the presence of the Government.

1.4.51 Polling (All protocols)

A device periodically requesting data from another device.

1.4.52 Points (All protocols)

Physical and virtual inputs and outputs. See also paragraph INPUT/OUTPUT (I/O).

1.4.53 Program ID (LonWorks)

An identifier (number) stored in the device that identifies the node manufacturer, functionality of device (application & sequence), transceiver used, and the intended device usage.

1.4.54 Proportional, Integral, and Derivative (PID) Control Loop (All protocols)

Three parameters used to control modulating equipment to maintain a setpoint. Derivative control is often not required for HVAC systems (leaving "PI" control).

1.4.55 Repeater (All protocols)

A device that connects two control network segments and retransmits all information received on one side onto the other.

1.4.56 Router (All protocols)

A device that connects two CEA-709.1-D channels and controls traffic between the two by retransmitting signals received from one side onto the other based on the signal destination. Routers are used to subdivide a LonWorks control network and to limit network traffic.

1.4.57 Segment (All protocols)

A 'single' section of a control network that contains no repeaters or routers. There is generally a limit on the number of devices on a segment, and this limit is dependent on the topology/media and device type. For example, in a LonWorks system a TP/FT-10 network with locally powered devices is limited to 64 devices per segment.

1.4.58 Service Pin (LonWorks)

A hardware push-button on a device which causes the device to broadcast a message (over the control network) containing its Node ID and Program ID.

1.4.59 Standard Configuration Property Type (SCPT) (LonWorks)

Pronounced skip-it. A standard format type (maintained by LonMark International) for Configuration Properties.

1.4.60 Standard Network Variable Type (SNVT) (LonWorks)

Pronounced snivet. A standard format type (maintained by LonMark International) used to define data information transmitted and received by the individual nodes. The term SNVT is used in two ways. Technically it is the acronym for Standard Network Variable Type, and is sometimes used in this manner. However, it is often used to indicate the network

variable itself (i.e. it can mean "a network variable of a standard network variable type"). In general, the intended meaning should be clear from the context.

1.4.61 Subnet (LonWorks)

Consists of a logical grouping of up to 127 nodes, where the logical grouping is defined by node addressing. Each subnet is assigned a number which is unique within the Domain. See also paragraph NODE ADDRESS.

1.4.62 TP/FT-10 (LonWorks)

A Free Topology Twisted Pair network defined by CEA-709.3. This is the most common media type for a CEA-709.1-D control network.

1.4.63 TP/XF-1250 (LonWorks)

A high speed (1.25 Mbps) twisted pair, doubly-terminated bus network defined by the LonMark Interoperability Guidelines. This media is typically used only as a backbone media to connect multiple TP/FT-10 networks.

1.4.64 User-defined Configuration Property Type (UCPT) (LonWorks)

Pronounced u-keep-it. A Configuration Property format type that is defined by the device manufacturer.

1.4.65 User-defined Network Variable Type (UNVT) (LonWorks)

A network variable format defined by the device manufacturer. Note that UNVTs create non-standard communications (other vendor's devices may not correctly interpret it) and may close the system and therefore are not permitted by this specification.

1.4.66 UMCS (All protocols)

UMCS stands for Utility Monitoring and Control System. The term refers to all components by which a project site monitors, manages, and controls real-time operation of HVAC and other building systems. These components include the UMCS "front-end" and all field building control systems connected to the front-end. The front-end consists of Monitoring and Control Software (user interface software), browser-based user interfaces and network infrastructure.

The network infrastructure (the "UMCS Network"), is an IP network connecting multiple building or facility control networks to the Monitoring and Control Software.

1.4.67 UMCS Network (All protocols)

The UMCS Network connects multiple building or facility control networks to the Monitoring and Control Software.

1.5 PROJECT SEQUENCING

TABLE I: PROJECT SEQUENCING lists the sequencing of submittals as specified in paragraph SUBMITTALS (denoted by an 'S' in the 'TYPE' column) and activities as specified in PART 3 EXECUTION (denoted by an 'E' in the 'TYPE' column). TABLE I does not specify overall project milestone and

completion dates; these dates are specified in the contract documents.

a. Sequencing for Submittals: The sequencing specified for submittals is the deadline by which the submittal must be initially submitted to the Government. Following submission there will be a Government review period as specified in Section 01 33 00 SUBMITTAL PROCEDURES. If the submittal is not accepted by the Government, revise the submittal and resubmit it to the Government within 14 days of notification that the submittal has been rejected. Upon resubmittal there will be an additional Government review period. If the submittal is not accepted the process repeats until the submittal is accepted by the Government.

b. Sequencing for Activities: The sequencing specified for activities indicates the earliest the activity may begin.

c. Abbreviations: In TABLE I the abbreviation AAO is used for 'after approval of' and 'ACO' is used for 'after completion of'.

TABLE I. PROJECT SEQUENCING

ITEM #	TYPE	DESCRIPTION	SEQUENCING (START OF ACTIVITY OR DEADLINE FOR SUBMITTAL)
1	S	Existing Conditions Report	
2		DDC Contractor Design Drawings-Meeting	
3	S	DDC Contractor Design Drawings	
4	S	Manufacturer's Product Data	
5	S	Pre-construction QC Checklist	
6	E	Install Building Control System	AAO #1 thru #4
7	E	Start-Up and Start-Up Testing	ACO #5
8	S	Post-Construction QC Checklist	ACO #6
9	S	Programming Software Configuration Software Niagara Framework Engineering Tool Niagara Framework Wizards XIF Files	ACO #6
10	S	Draft As-Built Drawings	ACO #6
11	S	Start-Up Testing Report	ACO #6

TABLE I. PROJECT SEQUENCING			
ITEM #	TYPE	DESCRIPTION	SEQUENCING (START OF ACTIVITY OR DEADLINE FOR SUBMITTAL)
12	S	PVT Procedures	Before schedule start of #12 and AAO #10
13	E	Execute PVT	AAO #9 and #11
14	S	PVT Report	ACO #12
15	S	Controller Application Programs Controller Configuration Settings Niagara Framework Supervisory Gateway Backups	AO #13
16	S	Final As-Built Drawings	AAO #13
17	S	O&M Instructions	AAO #15
18	S	Training Documentation	AAO #10 and before scheduled start of #18
19	E	Training	AAO #16 and #17
20	S	Closeout QC Checklist	ACO #18

1.6 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submittals with an "AE" are for submittal to the Designer of Record. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

DDC Contractor Design Drawings; G, AE

Draft As-Built Drawings; G, AE

Final As-Built Drawings; G, AE

SD-03 Product Data

Certificate of Networthiness Documentation; G, AE

Programming Software; G, AE

Controller Application Programs; G, AE

Manufacturer's Product Data; G, AE

Niagara Framework Supervisory Gateway Backups; G, AE

Niagara Framework Engineering Tool; G, AE

Niagara Framework Wizards; G, AE

SD-05 Design Data

Boiler Or Chiller Plant Gateway Request

SD-06 Test Reports

Existing Conditions Report

Start-Up Testing Report; G, AE

PVT Procedures; G, AE

PVT Report; G, AE

Pre-Construction Quality Control (QC) Checklist; G, AE

Post-Construction Quality Control (QC) Checklist; G, AE

Control Contractor’s Performance Verification Testing Plan; G, RO

Equipment Supplier’s Performance Verification Testing Plan; G, RO

Endurance Testing Results; G, RO

Performance Verification Test Report; G, RO

SD-10 Operation and Maintenance Data

Operation and Maintenance (O&M) Instructions; G, AE

Training Documentation; G, AE

SD-11 Closeout Submittals

Enclosure Keys; G, AE

Password Summary Report; G, AE

Closeout Quality Control (QC) Checklist; G, AE

1.7 DATA PACKAGE AND SUBMITTAL REQUIREMENTS

Technical data packages consisting of technical data and computer software (meaning technical data which relates to computer software) which are specifically identified in this project and which may be defined/required in other specifications must be delivered strictly in accordance with the

CONTRACT CLAUSES and in accordance with the Contract Data Requirements List, DD Form 1423. Data delivered must be identified by reference to the particular specification paragraph against which it is furnished. All submittals not specified as technical data packages are considered 'shop drawings' under the Federal Acquisition Regulation Supplement (FARS) and must contain no proprietary information and be delivered with unrestricted rights.

1.8 SOFTWARE FOR DDC HARDWARE AND GATEWAYS

Provide all software related to the programming and configuration of DDC Hardware and Gateways as indicated. License all Software to the project site. The term "controller" as used in these requirements means both DDC Hardware and Gateways.

1.8.1 Programming Software

For each type of General Purpose Programmable Controller (GPPC), provide the licensed programming software in accordance with Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. For each type of Application Generic Controller (AGC) provided without a configuration and programming Wizard, provide the licensed programming and configuration software in accordance with Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. Submit hard copies of user manuals for each software with the software submittal.

Submit Programming Software on CD-ROM as a Technical Data Package. Submit hard copies of the software user manual for each piece of licensed software.

1.8.2 Controller Application Programs

For each General Purpose Programmable Controller (GPPC), provide copies of the application program as source code compatible with the licensed programming software for that GPPC in accordance with Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. For each Application Generic Controller (AGC), provide copies of the application program as source code compatible with the programming and configuration tool for that AGC in accordance with Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

Submit Controller Application Programs on CD-ROM as a Technical Data Package. Include on the CD-ROM a list or table of contents clearly indicating which application program is associated with each device. Submit 2 copies of the licensed Controller Application Programs CD-ROM.

1.8.3 Niagara Framework Wizards (for Niagara LonWorks systems)

For each Application Generic Controller with a Niagara Framework Wizard and for each Application Specific Controller provide licensed Niagara Framework Wizards in accordance with Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. Submit hard copy manuals, if available, for each Wizard provided as part of the Niagara Framework Wizards submittal.

Submit licensed Niagara Framework Wizards on CD-ROM as a Technical Data Package. Include on the CD-ROM a list or table of contents clearly

indicating which files are associated with each device. Submit hard copies of the software user manual, if available, for each Wizard.

1.8.4 Niagara Framework Supervisory Gateway Backups

For each Niagara Framework Supervisory Gateway, provide a backup of all software within the Niagara Framework Supervisory Gateway, including configuration settings. This backup must be sufficient to allow the restoration of the Niagara Framework Supervisory Gateway or the replacement of the Niagara Framework Supervisory Gateway.

Submit backups for each Niagara Framework Supervisory Gateway on CD-ROM as a Technical Data Package. Mark each backup indicating clearly the source Niagara Framework Supervisory Gateway.

1.8.5 Niagara Framework Engineering Tool(for all Niagara Framework system)

Provide a licensed Niagara Framework Engineering Tool in accordance with Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. Submit software user manuals with the Niagara Framework Engineering Tool submittal.

Submit the licensed Niagara Framework Engineering Tool on CD-ROM as a Technical Data Package. Submit hard copies of the software user manual for the Niagara Framework Engineering Tool.

1.8.6 Certificate of Networthiness Documentation

For all software provided, provide documentation that an Enterprise Certificate of Networthiness exists, that a Limited Certificate of Networthiness for the project site exists, or provide a completed Certificate of Networthiness "Application Checklist". Submit Certificate of Networthiness Documentation in PDF format on CD-ROM.

1.9 BOILER OR CHILLER PLANT GATEWAY REQUEST

If requesting the use of a gateway to a boiler or chiller plant as indicated in Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS, submit a Boiler or Chiller Plant Gateway Request describing the configuration of the boilers or chillers including model numbers for equipment and controllers, the sequence of operation for the units, and a justification for the need to operate the units on a shared non-LonWorks network.

1.10 QUALITY CONTROL CHECKLISTS

The QC Checklist for Niagara Framework Based LonWorks Systems in APPENDIX A of this Section must be completed by the Contractor's Chief Quality Control (QC) Representative and submitted as indicated.

The QC Representative must verify each item indicated and initial in the space provided to indicate that the requirement has been met. The QC Representative must sign and date the Checklist prior to submission to the Government.

1.10.1 Pre-Construction Quality Control (QC) Checklist

Complete items indicated as Pre-Construction QC Checklist items in the QC Checklist. Submit four copies of the Pre-Construction QC Checklist.

1.10.2 Post-Construction Quality Control (QC) Checklist

Complete items indicated as Post-Construction QC Checklist items in the QC Checklist. Submit four copies of the Post-Construction QC Checklist.

1.10.3 Closeout Quality Control (QC) Checklist

Complete items indicated as Closeout QC Checklist items in the QC Checklist. Submit four copies of the Closeout QC Checklist.

PART 2 PRODUCTS

Provide products meeting the requirements of Section 23 09 13 INSTRUMENTATION AND CONTROL DEVICES FOR HVAC, Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS for LNS LonWorks systems or Niagara LonWorks systems, other referenced Sections, and this Section.

2.1 GENERAL PRODUCT REQUIREMENTS

Units of the same type of equipment must be products of a single manufacturer. Each major component of equipment must have the manufacturer's name and address, and the model and serial number in a conspicuous place. Materials and equipment must be standard products of a manufacturer regularly engaged in the manufacturing of these and similar products. The standard products must have been in a satisfactory commercial or industrial use for two years prior to use on this project. The two year use must include applications of equipment and materials under similar circumstances and of similar size. DDC Hardware not meeting the two-year field service requirement is acceptable provided it has been successfully used by the Contractor in a minimum of two previous projects. The equipment items must be supported by a service organization. Items of the same type and purpose must be identical, including equipment, assemblies, parts and components.

2.2 PRODUCT DATA

Provide manufacturer's product data sheets documenting compliance with product specifications for each product provided under Section 23 09 13 INSTRUMENTATION AND CONTROL DEVICES FOR HVAC, Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS, or this Section. Provide product data for all products in a single indexed compendium, organized by product type.

For all LonWorks hardware: for each manufacturer, model and version (revision) of DDC Hardware indicate the type or types of DDC Hardware the product is being provided as in accordance with Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

Submit Manufacturer's Product Data on CD-ROM.

2.2.1 XIF Files

Provide External Interface Files (XIF Files) for DDC Hardware in accordance with Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. Submit external interface files (XIF files) as a technical data package for each model of DDC Hardware provided under this specification. Submit XIF files on CD-ROM.

2.3 OPERATION ENVIRONMENT

Unless otherwise specified, provide products rated for continuous operation under the following conditions:

a. Pressure: Pressure conditions normally encountered in the installed location.

b. Vibration: Vibration conditions normally encountered in the installed location.

c. Temperature:

(1) Products installed indoors: Ambient temperatures in the range of 32 to 112 degrees F and temperature conditions outside this range normally encountered at the installed location.

(2) Products installed outdoors or in unconditioned indoor spaces: Ambient temperatures in the range of -35 to +151 degrees F and temperature conditions outside this range normally encountered at the installed location.

d. Humidity: 10 to 95 percent relative humidity, noncondensing and humidity conditions outside this range normally encountered at the installed location.

2.4 WIRELESS CAPABILITY

For products incorporating any wireless capability (including but not limited to radio frequency (RF), infrared and optical), provide products for which wireless capability can be permanently disabled at the device. Optical and infrared capabilities may be disabled via a permanently affixed opaque cover plate.

2.5 ENCLOSURES

Enclosures supplied as an integral (pre-packaged) part of another product are acceptable. Provide two Enclosure Keys for each lockable enclosure on a single ring per enclosure with a tag identifying the enclosure the keys operate. Provide enclosures meeting the following minimum requirements:

2.5.1 Outdoors

For enclosures located outdoors, provide enclosures meeting NEMA 250 Type 4 requirements.

2.5.2 Mechanical and Electrical Rooms

For enclosures located in mechanical or electrical rooms, provide enclosures meeting NEMA 250 Type 2 requirements.

2.5.3 Other Locations

For enclosures in other locations including but not limited to occupied spaces, above ceilings, and in plenum returns, provide enclosures meeting NEMA 250 Type 1 requirements.

2.6 WIRE AND CABLE

Provide wire and cable meeting the requirements of NFPA 70 and NFPA 90A in addition to the requirements of this specification and referenced specifications.

2.6.1 Terminal Blocks

For terminal blocks which are not integral to other equipment, provide terminal blocks which are insulated, modular, feed-through, clamp style with recessed captive screw-type clamping mechanism, suitable for DIN rail mounting, and which have enclosed sides or end plates and partition plates for separation.

2.6.2 Control Wiring for Binary Signals

For Control Wiring for Binary Signals, provide 18 AWG copper or thicker wire rated for 300-volt service.

2.6.3 Control Wiring for Analog Signals

For Control Wiring for Analog Signals, provide 18 AWG or thicker, copper, single- or multiple-twisted wire meeting the following requirements:

a. minimum 2 inch lay of twist

b. 100 percent shielded pairs

c. at least 300-volt insulation

d. each pair has a 20 AWG tinned-copper drain wire and individual overall pair insulation

e. cables have an overall aluminum-polyester or tinned-copper cable-shield tape, overall 20 AWG tinned-copper cable drain wire, and overall cable insulation.

2.6.4 Power Wiring for Control Devices

For 24-volt circuits, provide insulated copper 18 AWG or thicker wire rated for 300 VAC service. For 120-volt circuits, provide 14 AWG or thicker stranded copper wire rated for 600-volt service.

2.6.5 Transformers

Provide UL 5085-3 approved transformers. Select transformers sized so that the connected load is no greater than 80 percent of the transformer rated capacity.

PART 3 EXECUTION

3.1 EXISTING CONDITIONS

3.1.1 Existing Conditions Survey

Perform a field survey, including testing and inspection of the equipment to be controlled and submit an Existing Conditions Report documenting the current status and its impact on the Contractor's ability to meet this specification. For those items considered nonfunctional, document the

deficiency in the report including explanation of the deficiencies and estimated costs to correct the deficiencies. As part of the report, define the scheduled need date for connection to existing equipment. Make written requests and obtain Government approval prior to disconnecting any controls and obtaining equipment downtime.

Submit four copies of the Existing Conditions Report.

3.1.2 Existing Equipment Downtime

Make written requests and obtain Government approval prior to disconnecting any controls and obtaining equipment downtime.

3.1.3 Existing Control System Devices

Inspect, calibrate, and adjust as necessary to place in proper working order all existing devices which are to be reused.

3.2 INSTALLATION

Fully install and test the control system in accordance Section 23 09 13 INSTRUMENTATION AND CONTROL DEVICES FOR HVAC, Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS for LNS LonWorks systems or Niagara LonWorks systems, and this Section.

3.2.1 Dielectric Isolation

Provide dielectric isolation where dissimilar metals are used for connection and support. Install control system in a matter that provides clearance for control system maintenance by maintaining access space required to calibrate, remove, repair, or replace control system devices. Install control system such that it does not interfere with the clearance requirements for mechanical and electrical system maintenance.

3.2.2 Penetrations in Building Exterior

Make all penetrations through and mounting holes in the building exterior watertight.

3.2.3 Device Mounting Criteria

Install devices in accordance with the manufacturer's recommendations and as indicated and shown. Provide a weathershield for all devices installed outdoors. Provide clearance for control system maintenance by maintaining access space required to calibrate, remove, repair, or replace control system devices. Provide clearance for mechanical and electrical system maintenance; do not not interfere with the clearance requirements for mechanical and electrical system maintenance.

3.2.4 Labels and Tags

Key all labels and tags to the unique identifiers shown on the As-Built drawings. For labels exterior to protective enclosures provide engraved plastic labels mechanically attached to the enclosure or DDC Hardware. Labels inside protective enclosures may be attached using adhesive, but must not be hand written. For tags, provide plastic or metal tags mechanically attached directly to each device or attached by a metal chain or wire.

a. Label all Enclosures and DDC Hardware.

b. Tag Airflow measurement arrays (AFMA) with flow rate range for signal output range, duct size, and pitot tube AFMA flow coefficient.

c. Tag duct static pressure taps at the location of the pressure tap

3.2.5 Surge Protection

3.2.5.1 Power-Line Surge Protection

Protect equipment connected to AC circuits to withstand power-line surges in accordance with IEEE C62.41. Do not use fuses for surge protection.

3.2.5.2 Surge Protection for Transmitter and Control Wiring

Protect DDC hardware against or provided DDC hardware capable of withstanding surges induced on control and transmitter wiring installed outdoors and as shown. Protect equipment against the following two waveforms:

a. A waveform with a 10-microsecond rise time, a 1000-microsecond decay time and a peak current of 60 amps.

b. A waveform with an 8-microsecond rise time, a 20-microsecond decay time and a peak current of 500 amperes.

3.2.6 Basic Cybersecurity Requirements

3.2.6.1 Passwords

For all devices with a password, change the password from the default password. Do not use the same password for more than one device. Coordinate selection of passwords with Facilities Department. Provide a Password Summary Report documenting the password for each device and describing the procedure to change the password for each device.

Provide two hardcopies of the Password Summary Report, each copy in its own sealed envelope.

3.2.6.2 Wireless Capability

Unless otherwise indicated, disable wireless capability (including but not limited to radio frequency (RF), infrared and optical) for all devices with wireless capability. Optical and infrared capabilities may be disabled via a permanently affixed opaque cover plate. Password protecting a wireless connections does not meet this requirement; the wireless capability must be disabled.

3.2.6.3 IP Network Physical Security

Install all IP Network media in conduit. Install all IP devices including but not limited to IP-enabled DDC hardware and IP Network Hardware in lockable enclosures.

3.3 DRAWINGS AND CALCULATIONS

After the submission of the existing conditions report and prior to the development of DDC Contractor Design Drawings, a coordination meeting

including DPW, USACE, the Contractor, and the A/E is required to review all BAS controls and integration into the existing UMCS.

Provide drawings in the form and arrangement indicated and shown. Use the same abbreviations, symbols, nomenclature and identifiers shown. Assign a unique identifier as shown to each control system element on a drawing. When packaging drawings, group schedules by system. When space allows, it is permissible to include multiple schedules for the same system on a single sheet. Except for drawings covering all systems, do not put information for different systems on the same sheet.

Submit hardcopy drawings on A3 17 by 11 inches sheets, and electronic drawings in PDF and in AutoCAD format. In addition, submit electronic drawings in editable Excel format for all drawings that are tabular, including but not limited to the Point Schedule and Equipment Schedule.

a. Submit DDC Contractor Design Drawings consisting of each drawing indicated with pre-construction information depicting the intended control system design and plans. Submit DDC Contractor Design Drawings as a single complete package: 4 hard copies and 2 copies on CD-ROM.

b. Submit Draft As-Built Drawings consisting of each drawing indicated updated with as-built data for the system prior to PVT. Submit Draft As-Built Drawings as a single complete package: 4 hard copies and 2 copies on CD-ROM.

c. Submit Final As-Built Drawings consisting of each drawing indicated updated with all final as-built data. Final As-Built Drawings as a single complete package: 4 hard copies and 2 copies on CD-ROM.

3.3.1 Sample Drawings

Sample drawings in electronic format are available at the Whole Building Design Guide page for this section: http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-23-09-00 These drawings may prove useful in demonstrating expected drawing formatting and example content and are provided for illustrative purposes only. Note that these drawings do not meet the content requirements of this Section and must be completed to meet project requirements.

3.3.2 Drawing Index and Legend

Provide an HVAC Control System Drawing Index showing the name and number of the building, military site, State or other similar designation, and Country. In the Drawing Index, list all Contractor Design Drawings, including the drawing number, sheet number, drawing title, and computer filename when used. In the Design Drawing Legend, show and describe all symbols, abbreviations and acronyms used on the Design Drawings. Provide a single Index and Legend for the entire drawing package.

3.3.3 Thermostat and Occupancy Sensor Schedule

Provide a thermostat and occupancy sensor schedule containing each thermostat's unique identifier, room identifier and control features and functions as shown. Provide a single thermostat and occupancy sensor schedule for the entire project.

3.3.4 Valve Schedule

Provide a valve schedule containing each valve's unique identifier, size, flow coefficient Kv (Cv), pressure drop at specified flow rate, spring range, positive positioner range, actuator size, close-off pressure to torque data, dimensions, and access and clearance requirements data. In the valve schedule include actuator selection data supported by calculations of the force required to move and seal the valve, access and clearance requirements. Provide a single valve schedule for the entire project.

3.3.5 Damper Schedule

Provide a damper schedule containing each damper's unique identifier, type (opposed or parallel blade), nominal and actual sizes, orientation of axis and frame, direction of blade rotation, actuator size and spring ranges, operation rate, positive positioner range, location of actuators and damper end switches, arrangement of sections in multi-section dampers, and methods of connecting dampers, actuators, and linkages. Include the AMCA 511 maximum leakage rate at the operating static-pressure differential for each damper in the Damper Schedule. Provide a single damper schedule for the entire project.

3.3.6 Project Summary Equipment Schedule

Provide a project summary equipment schedule containing the manufacturer, model number, part number and descriptive name for each control device, hardware and component provided under this specification. Provide a single project equipment schedule for the entire project.

3.3.7 Equipment Schedule

Provide system equipment schedules containing the unique identifier, manufacturer, model number, part number and descriptive name for each control device, hardware and component provided under this specification. Provide a separate equipment schedule for each HVAC system.

3.3.8 Occupancy Schedule

Provide an occupancy schedule drawing containing the same fields as the occupancy schedule Contract Drawing with Contractor updated information. Provide a single occupancy schedule for the entire project.

3.3.9 DDC Hardware Schedule

Provide a single DDC Hardware Schedule for the entire project and including following information for each device.

3.3.9.1 DDC Hardware Identifier

The Unique DDC Hardware Identifier for the device.

3.3.9.2 HVAC System

The system "name" used to identify a specific system (the name used on the system schematic drawing for that system).

3.3.9.3 LonWorks Device Information

3.3.9.3.1 Network Address

The LonWorks Domain, Subnet and Node address for the device.

3.3.9.3.2 Unique Node ID

The Unique 48-bit Node ID associated with the device. (Also referred to as the Neuron ID for some devices)

3.3.9.4 Niagara Station ID

The Niagara Station ID for each Niagara Framework Supervisory Gateway

3.3.10 Points Schedule

Provide a Points Schedule in tabular form for each HVAC system, with the indicated columns and with each row representing a hardware point, network point or configuration point in the system.

a. When a Points Schedule was included in the Contract Drawing package, use the same fields as the Contract Drawing and expand to inlude the columns below, with updated information in addition to the indicated fields.

Points Schedule Columns must include:

3.3.10.1 Point Name

The abbreviated name for the point using the indicated naming convention.

3.3.10.2 Description

A brief functional description of the point such as "Supply Air Temperature".

3.3.10.3 DDC Hardware Identifier

The Unique DDC Hardware Identifier shown on the DDC Hardware Schedule and used across all drawings for the DDC Hardware containing the point.

3.3.10.4 Settings

The value and units of any setpoints, configured setpoints, configuration parameters, and settings related to each point.

3.3.10.5 Range

The range of values, including units, associated with the point, including but not limited to a zone temperature setpoint adjustment range, a sensor measurement range, occupancy values for an occupancy input, or the status of a safety.

3.3.10.6 Input or Output (I/O) Type

The type of input or output signal associated with the point. Use the following abbreviations for entries in this column:

a. AI: The value comes from a hardware (physical) Analog Input

b. AO: The value is output as a hardware (physical) Analog Output

c. BI: The value comes from a hardware (physical) Binary Input

d. BO: The value is output as a hardware (physical) Binary Output

e. PULSE: The value comes from a hardware (physical) Pulse Accumulator Input

f. NET-IN: The value is provided from the network (generally from another device). Use this entry only when the value is received from another device as part of scheduling or as part of a sequence of operation, not when the value is received on the network for supervisory functions such as trending, alarming, override or display at a user interface.

g. NET-OUT: The value is provided to another controller over the network. Use this entry only when the value is transmitted to another device as part of scheduling or as part of a sequence of operation, not when the value is transmitted on the network for supervisory functions such as trending, alarming, override or display at a user interface.

3.3.10.7 Primary Point Information: SNVT Name

The name of the SNVT used for the point. Any point that is displayed at the front end or on an LDP, is trended, is used by another device on the network, or has an alarm condition must be documented here.

3.3.10.8 Primary Point Information: SNVT Type

The SNVT type used by the point. Provide this information whenever SNVT Name is required.

3.3.10.9 Niagara Station ID

The Niagara Station ID of the Niagara Framework Supervisory Gateway the point is mapped into.

3.3.10.10 Override Information (SNVT Name and Type)

For each point requiring an Override and not residing in a Niagara Framework Supervisory Gateway, indicate the SNVT Name and SNVT Type of the network variable used for the override.

3.3.10.11 Configuration Information

Indicate the means of configuration associated with each point. For points in a Niagara Framework Supervisory Gateway, indicate the point within the Niagara Framework Supervisory Gateway used to configure the value. For other points:

a. Indicate "Niagara Framework Wizard" if the point is configurable via a Niagara Framework Wizard.

b. If the point is not configurable through a Niagara Framework Wizard, indicate the network variable or configuration property used to

configure the value.

3.3.11 Riser Diagram

The Riser Diagram of the Building Control Network may be in tabular form, and must show all DDC Hardware and all Network Hardware, including network terminators. For each item, provide the unique identifier, common descriptive name, physical sequential order (previous and next device on the network), room identifier and location within room. A single riser diagram must be submitted for the entire system.

3.3.12 Control System Schematics

Provide control system schematics in the same form as the control system schematic Contract Drawing with Contractor updated information. Provide a control system schematic for each HVAC system.

3.3.13 Sequences of Operation Including Control Logic Diagrams

Provide HVAC control system sequence of operation and control logic diagrams in the same format as the Contract Drawings. Within these drawings, refer to devices by their unique identifiers. Submit sequences of operation and control logic diagrams for each HVAC system

3.3.14 Controller, Motor Starter and Relay Wiring Diagram

Provide controller wiring diagrams as functional wiring diagrams which show the interconnection of conductors and cables to each controller and to the identified terminals of input and output devices, starters and package equipment. Show necessary jumpers and ground connections and the labels of all conductors. Identify sources of power required for control systems and for packaged equipment control systems back to the panel board circuit breaker number, controller enclosures, magnetic starter, or packaged equipment control circuit. Show each power supply and transformer not integral to a controller, starter, or packaged equipment. Show the connected volt-ampere load and the power supply volt-ampere rating. Provide wiring diagrams for each HVAC system.

3.4 CONTROLLER TUNING

Tune each controller in a manner consistent with that described in the ASHRAE FUN IP and in the manufacturer's instruction manual. Tuning must consist of adjustment of the proportional, integral, and where applicable, the derivative (PID) settings to provide stable closed-loop control. Each loop must be tuned while the system or plant is operating at a high gain (worst case) condition, where high gain can generally be defined as a low-flow or low-load condition. Upon final adjustment of the PID settings, in response to a change in controller setpoint, the controlled variable must settle out at the new setpoint with no more than two (2) oscillations above and below setpoint. Upon settling out at the new setpoint the controller output must be steady. With the exception of naturally slow processes such as zone temperature control, the controller must settle out at the new setpoint within five (5) minutes. Set the controller to its correct setpoint and record and submit the final PID configuration settings with the O&M Instructions and on the associated Points Schedule.

3.5 START-UP

3.5.1 Start-Up Test

Perform the following startup tests for each control system to ensure that the described control system components are installed and functioning per this specification.

Adjust, calibrate, measure, program, configure, set the time schedules, and otherwise perform all necessary actions to ensure that the systems function as indicated and shown in the sequence of operation and other contract documents.

3.5.1.1 Systems Check

An item-by-item check must be performed for each HVAC system

3.5.1.1.1 Step 1 - System Inspection

With the system in unoccupied mode and with fan hand-off-auto switches in the OFF position, verify that power and main air are available where required and that all output devices are in their failsafe and normal positions. Inspect each local display panel and each M&C Client to verify that all displays indicate shutdown conditions.

3.5.1.1.2 Step 2 - Calibration Accuracy Check

Perform a two-point accuracy check of the calibration of each HVAC control system sensing element and transmitter by comparing the value from the test instrument to the network value provided by the DDC Hardware. Use digital indicating test instruments, such as digital thermometers, motor-driven psychrometers, and tachometers. Use test instruments with accuracy at least twice as accurate as the specified sensor accuracy and with calibration traceable to National Institute of Standards and Technology standards. Check one the first check point in the bottom one-third of the sensor range, and the second in the top one-third of the sensor range. Verify that the sensing element-to-DDC readout accuracies at two points are within the specified product accuracy tolerances, and if not recalibrate or replace the device and repeat the calibration check.

3.5.1.1.3 Step 3 - Actuator Range Check

With the system running, apply a signal to each actuator through the DDC Hardware controller. Verify proper operation of the actuators and positioners for all actuated devices and record the signal levels for the extreme positions of each device. Vary the signal over its full range, and verify that the actuators travel from zero stroke to full stroke within the signal range. Where applicable, verify that all sequenced actuators move from zero stroke to full stroke in the proper direction, and move the connected device in the proper direction from one extreme position to the other. For valve actuators and damper actuators, perform the actuator range check under normal system pressures.

3.5.1.2 Weather Dependent Test

Perform weather dependent test procedures in the appropriate climatic season.

3.5.2 Start-Up Testing Report

Submit 4 copies of the Start-Up Testing Report. The report may be submitted as a Technical Data Package documenting the results of the tests performed and certifying that the system is installed and functioning per this specification, and is ready for the Performance Verification Test (PVT).

3.6 PERFORMANCE VERIFICATION TEST (PVT)

3.6.1 PVT Procedures

Prepare PVT Procedures explaining step-by-step, the actions and expected results that will demonstrate that the control system performs in accordance with the sequences of operation, and other contract documents. Submit 4 copies of the PVT Procedures. The PVT Procedures may be submitted as a Technical Data Package.

3.6.1.1 Sensor Accuracy Checks

Include a one-point accuracy check of each sensor in the PVT procedures.

3.6.1.2 Endurance Test

Include a one-week endurance test as part of the PVT during which the system is operated continuously.

Use the building control system Niagara Trend Log Objects to trend all points shown as requiring a trend on the Point Schedule for the entire endurance test. If insufficient buffer capacity exists to trend the entire endurance test, upload trend logs during the course of the endurance test to ensure that no trend data is lost. The PVT must include a methodology to measure and record the network bandwidth usage on each TP/FT-10 channel during the endurance test.

3.6.1.3 PVT Equipment List

Include in the PVT procedures a control system performance verification test equipment list that lists the equipment to be used during performance verification testing. For each piece of equipment, include manufacturer name, model number, equipment function, the date of the latest calibration, and the results of the latest calibration

3.6.2 PVT Execution

Demonstrate compliance of the control system with the contract documents. Using test plans and procedures approved by the Government, software capable of reading and writing COV Notification Subscriptions, Notification Class Recipient List Properties, event enrollments, demonstrate all physical and functional requirements of the project. Show, step-by-step, the actions and results demonstrating that the control systems perform in accordance with the sequences of operation. Do not start the performance verification test until after receipt of written permission by the Government, based on Government approval of the PVT Plan and Draft As-Builts and completion of balancing. UNLESS GOVERNMENT WITNESSING OF A TEST IS SPECIFICALLY WAIVED BY THE GOVERNMENT, PERFORM ALL TESTS WITH A GOVERNMENT WITNESS. Do not conduct tests during scheduled seasonal off periods of base heating and cooling systems. If the system experiences any failures during the endurance test portion of the PVT,

repair the system repeat the endurance test portion of the PVT until the system operates continuously and without failure for the specified endurance test period.

3.6.3 PVT Report

Prepare and submit a PVT report documenting all tests performed during the PVT and their results. Include all tests in the PVT procedures and any additional tests performed during PVT. Document test failures and repairs conducted with the test results.

Submit four copies of the PVT Report. The PVT Report may be submitted as a Technical Data Package.

3.7 PERFORMANCE VERIFICATION TESTING

3.7.1 General

PVT testing must demonstrate compliance of controls work with contract document requirements and must be performed by the Controls Contractor and Equipment Suppliers.

3.7.2 Performance Verification Testing and Commissioning

PVT testing is a Government quality assurance function that includes systems trending and field tests. Commissioning is a quality control function that is the Commissioning Team’s responsibility to the extent required by this contract.

3.7.3 Performance Verification Testing of Equipment with Packaged Controls

Controls Contractor and Equipment Supplier(s) must share and coordinate PVT testing responsibilities for equipment provided with on-board factory packaged controls such as boiler controllers, dedicated outside air systems (DOAS’s), and packaged pumping systems.

3.7.3.1 Controls Contractor Responsibilities

The Controls Contractor must provide a PVT Plan separate from Equipment Supplier’s performance verification testing plan, perform endurance testing, and perform PVT testing concurrent with Equipment Suppliers’ testing for equipment provided with on-board factory packaged controls to demonstrate the following:

a. Equipment enabling and disabling.

b. Equipment standard and optional control points necessary to accomplish functionality regardless if specified in contract documents or not.

c. Equipment standard and optional alarms critical to safe operation regardless if specified in contract documents or not.

d. All control points added by Controls Contractor in addition to onboard factory packaged controls regardless if specified in contract documents or not.

Refer to paragraphs titled “Performance Verification Test Plan” and “Endurance Testing” for additional information.

3.7.3.2 Equipment Supplier Responsibilities

Each Equipment Supplier must provide PVT Plans separate from Controls Contractor's plans and perform PVT testing concurrent with Controls Contractor's testing for their equipment provided with on-board factory packaged controls to demonstrate the following:

a. Equipment standard and optional control features necessary to accomplish functionality regardless if specified in contract documents or not.

b. Equipment standard and optional operation modes necessary to accomplish functionality regardless if specified in contract documents or not.

c. Equipment standard and optional alarm conditions for safe operation regardless if specified in contract documents or not.

Refer to all paragraphs under paragraph titled "Performance Verification Testing" except for section titled "Endurance Testing" for additional information.

3.7.4 Sequencing of Performance Verification Testing Activities

PVT activities must be sequenced with major activities listed below for Test and Balance (TAB) Contractor, Equipment Suppliers, Commissioning Specialists, and others to demonstrate fully functioning systems. Major activities as applicable to this contract must be sequenced as indicated in TABLE II: SEQUENCING OF PVT TESTING ACTIVITIES

TABLE II: SEQUENCING OF PVT TESTING ACTIVITIES

SEQUENCE	ITEM
1	Submission, review, and approval of Control Contractors PVT Plans.
2	Submission, review, and approval of Equipment Suppliers PVT Plans.
3	Submission, review, and approval of certified final Test and Balance Report.
4	Conduct endurance testing.
5	Submission, review, and approval of all of the Commissioning Specialists completed functional performance tests.
6	Submission, review, and approval of endurance testing.
7	Request Contracting Officer to allow beginning of Government-witnessed PVT testing.
8	Contracting Officers approval to begin PVT testing.
9	Conduct PVT field work.
10	Governments verbal approval of PVT field work for all systems.

TABLE II: SEQUENCING OF PVT TESTING ACTIVITIES	
SEQUENCE	ITEM
11	Conduct Test and Balance verification field work.
12	Governments written approval of Test and Balance verification field work.
13	Governments written approval of PVT field work for all systems.
14	Facility acceptance recommendation.
15	Submission, review, and approval of Control Contractors PVT Report.
16	Submission, review, and approval of Equipment Suppliers PVT Report.
17	Conduct endurance testing within 10 months of beneficial occupancy.
18	Submission, review, and approval of endurance testing within 10 months of beneficial occupancy.
19	Conduct PVT field work within 10 months of beneficial occupancy.

3.7.4.1 PVT Testing for Multi-Phase Construction

For air moving systems except outside air systems serving multiple phases, all major activities listed in TABLE II through Government’s verbal approval of Test and Balance verification field work can be completed by phase if all ductwork construction is completed for that phase.

For primary systems such as chilled water systems, HVAC heating hot water systems, and outside air systems serving multiple phases, all major activities listed listed in TABLE II through Government’s verbal approval of Test and Balance verification field work for all air moving systems served by that primary system for that phase must be completed prior to conducting PVT field work for that primary system.

3.7.5 Control Contractor's Performance Verification Testing Plan

Submit a detailed PVT Plan of the proposed control systems testing in this contract for approval prior to its use. Develop and use a single PVT Plan for each system with a unique control sequence. Systems sharing an identical control sequence can be tested using copies of the PVT Plan intended for these systems.

PVT Plans must include system-based, step-by-step test methods demonstrating system performs in accordance with contract document requirements. The Government may provide sample PVT Plans upon request. PVT Plans must include the following:

a. Control sequences from contract documents segmented such that each control algorithm, operation mode, and alarm condition is immediately followed by numbered test methods required to initiate a response, expected response, space for comments, and “pass" or "fail” indication for each expected response.

b. PVT Plans with control sequences from contract documents that are not

segmented into parts will not be accepted.

c. Indication where assisting personnel are required such as Mechanical Contractor.

d. Signature and date lines for the Contractor's PVT administrator, Contractor's quality assurance representative, and Contracting Officer's representative acknowledging completion of testing.

3.7.6 Performance Verification Testing Sample Size

PVT testing sample sizes will be as follows:

a. 100-Percent of the following systems:

(1) primary systems including, but not limited to, chilled water and HVAC heating hot water systems

(2) air handling unit systems including all associated fans except for remote exhaust air fans

(3) DOAS’s including all associated fans except for remote exhaust air fans

b. 20-Percent of each set of systems with a shared identical control sequence for systems such as:

(1) air terminal units

(2) exhaust air fans

(3) terminal equipment such as fan coil units and unit heaters

3.7.6.1 Selection of Systems to Test

For sample sets less than 100-percent, the Government will choose which systems will be tested. The Government may require additional testing if previous testing results are inconsistent or demonstrate improper system control as follows:

a. An additional 25-percent after five-percent failure rate of first sample set.

b. 100-percent after any failures occurring in additional sample set.

3.7.7 Conducting Performance Verification Testing

At least 15 days prior to preferred test date, request the Contracting Officer to allow the beginning of Government-witnessed PVT testing. Provide an estimated time table required to perform testing of each system. Furnish personnel, equipment, instrumentation, and supplies necessary to perform all aspects of testing. Testing personnel must be regularly employed in the testing and calibration of control systems. After receipt of Contracting Officer’s approval to begin testing, perform PVT testing using project's as-built (shop) control system drawings, project's design drawings, and approved PVT Plans.

During testing, identify deficiencies that do not meet contract document requirements. Deficiencies must be investigated, corrected with

corrections documented, and re-tested at a later date following procedures for the initial PVT testing. The Government may require re-testing of any control system components affected by the original failed test.

3.7.8 Endurance Testing

3.7.8.1 General

Conduct endurance testing for each system subject to PVT testing beginning when indicated in “Sequencing of Performance Verification Testing Activities”. Systems must be operating as normally anticipated during occupancy throughout endurance testing.

3.7.8.2 Hardware

Use hardware provided in this contract for testing.

If insufficient buffer capacity exists to trend the entire endurance test, upload trend data during the course of endurance testing to ensure all trend data is retained. Lost trend data will require retesting of all control points for affected system(s).

3.7.8.3 Endurance Testing Results Format

Submit endurance testing results for each tested system in a graphical format complete with clear indication of value(s) for y-axis, value for x-axis, and legend identifying each trended control point. The number of control points contained on a single graph must be such that all control points can be clearly visible. Control points must be logically grouped such that related points appear on a single graph. In addition, submit a separate comma separated value (CSV) file of raw trend data for each trended system. Each trended control point in CSV file must be clearly identified.

For control points recorded based on change of value, change of value for recording data must be clearly identified for each control point.

3.7.8.4 Endurance Testing Start, Duration, and Frequency

Trending of all control points for a given system must start at an identical date and time regardless of the basis of data collection. Duration of all endurance tests must be at least one-week.

Unless specified otherwise for control points recorded based on time, frequency of data collection must be 15-minutes. Frequency of data collection for specific types of control points is as follows:

3.7.8.4.1 Points Trended at One Minute Intervals

a. Temperature for supply air, return air, mixed air, supply water, and return water

b. Temperature for outside air, supply air, return air and exhaust air entering and leaving energy recovery device

c. Flow for supply air, return air, outside air, chilled water, and HVAC heating hot water

d. Flow for exhaust air associated with energy recovery

e. Relative humidity for outside air and return air

f. Relative humidity for outside air, supply air, return air and exhaust air entering and leaving energy recovery device

g. Command and status for control dampers and control valves

h. Speed for fans and pumps

i. Pressure for fans and pumps

3.7.8.4.2 Points Trended at 15 Minute Intervals

a. Temperature and relative humidity for zones

b. Temperature and relative humidity for outside air not associated with energy recovery

c. Command and status for equipment

d. Pressure relative to the outside for facility

3.7.8.5 Trended Control Points

Trended control points for each system must demonstrate each system performs in accordance with contract document requirements. Trended control points must include, but not be limited to, control points listed in contract document points list.

Minimum control points that are required to be trended for selected systems are listed below. These control points must be trended as applicable to this contract in addition to control points necessary to demonstrate systems perform in accordance with contract document requirements and those listed in contract document’s points list.

3.7.8.5.1 Air-Cooled Chiller Chilled Water System.

a. Chiller(s) command and status

b. Chiller isolation valve(s) command and status

c. Chilled water pump(s) actual speed

d. Chilled water pump(s) setpoint and actual differential pressure

e. Minimum flow bypass control valve command

f. Minimum system flow setpoint and actual flow

g. Chilled water supply setpoint and actual temperature

h. Chilled water return actual temperature

i. Chilled water actual flow

j. Outside air actual dry-bulb temperature

3.7.8.5.2 HVAC Heating Hot Water System with Boiler.

a. Boiler(s) command and status

b. Boiler(s) isolation valve command and status

c. HVAC heating hot water pump(s) actual speed

d. HVAC heating hot water pump(s) setpoint and actual differential pressure

e. Minimum flow bypass control valve command

f. Minimum system setpoint and actual flow

g. HVAC heating hot water supply setpoint and actual temperature

h. HVAC heating hot water return actual temperature

i. HVAC heating hot water actual flow

j. Outside air actual dry-bulb temperature

3.7.8.5.3 HVAC Heating Hot Water System with Steam-to-Hot Water Heat Exchanger.

a. Steam control valve(s) command

b. Heat exchanger isolation valve(s) command and status

c. HVAC heating hot water pump(s) actual speed

d. HVAC heating hot water pump(s) setpoint and actual differential pressure

e. Minimum flow bypass control valve command

f. Minimum system setpoint and actual flow

g. HVAC heating hot water supply setpoint and actual temperature

h. HVAC heating hot water return actual temperature

i. HVAC heating hot water actual flow

j. Outside air actual dry-bulb temperature

3.7.8.5.4 Air Handling Unit with Relief Air Fan

a. Outside air actual dry-bulb temperature

b. Outside air actual relative humidity

c. Outside air setpoint and actual airflow

d. Minimum outside air control damper command

e. Economizer outside air control damper command

f. Facility setpoint and actual relative pressure

g. Return air actual dry-bulb temperature

h. Return air actual relative humidity

i. Return air control damper command

j. Relief air control damper command

h. Relief air fan actual speed

i. Mixed air setpoint and setpoint and actual temperature

j. Preheat coil leaving air setpoint and actual temperature

k. Preheat coil control actuator command

l. Cooling coil leaving air setpoint and actual temperature

m. Cooling coil control valve command

n. Supply air fan actual speed

o. Discharge air actual temperature

p. Supply air fan setpoint and actual static pressure

3.7.8.5.5 Dedicated Outside Air System (DOAS)

a. Outside air actual dry-bulb temperature

b. Outside air actual relative humidity

c. Outside air isolation damper command and status

d. Outside air setpoint and actual airflow

e. Energy recovery wheel command, status, and actual speed

f. Energy recovery wheel’s OA bypass control damper command and status

g. Energy recovery wheel’s defrost cycle command and status

h. Energy recovery wheel’s OA discharge air actual dry-bulb temperature

i. Energy recovery wheel’s OA discharge air actual relative humidity

j. Preheat coil leaving air setpoint and actual temperature

h. Preheat coil control actuator command

i. Cooling coil leaving air setpoint and actual temperature

j. Cooling coil control valve command

k. Supply air fan actual speed

l. Reheat coil control valve command

m. Discharge air setpoint and actual temperature

n. Supply air fan setpoint and actual static pressure

o. Facility setpoint and actual relative pressure

p. Return air actual dry-bulb temperature

q. Return air actual relative humidity

r. Energy recovery wheel’s EA bypass control damper command and status

s. Energy recovery wheel’s EA discharge air actual dry-bulb temperature

t. Energy recovery wheel’s EA discharge air actual relative humidity

u. Exhaust air fan actual speed

v. Exhaust air isolation damper command and status

3.7.8.5.6 Series Fan-Powered Supply Air Terminal Units

a. Zone setpoint and actual dry-bulb temperature

b. Zone actual relative humidity

c. Control damper command

d. Fan command and status

e. Heating coil valve command

f. Airflow actual value

g. Leaving air actual temperature

3.7.8.6 Endurance Testing Sample Size

Endurance Testing sample sizes ware as follows:

a. 100-Percent of the following systems:

(1) primary systems including, but not limited to, chilled water and HVAC heating hot water systems

(2) air handling unit systems including all associated fans except for remote exhaust air fans

(3) DOAS’s including all associated fans except for remote exhaust air fans

b. 20-Percent of each set of systems with a shared identical control sequence for systems such as:

(1) air terminal units

(2) exhaust air fans

(3) terminal equipment such as fan coil units and unit heaters

3.7.8.6.1 Selection of Systems to Test

For sample sets less than 100-percent, the Government will choose which systems will be tested. The Government may require additional testing if previous testing results are inconsistent or demonstrate improper system control as follows:

a. An additional 25-percent after five-percent failure rate of first sample set.

b. 100-percent after any failures occurring in additional sample set.

3.7.9 Performance Verification Test Report

Submit a PVT Report after receiving Government’s written approval of PVT field work that is intended to document test results and final control system sequences and settings prior to turnover. The PVT Report must contain the following:

a. Executive summary that briefly discusses results of each system’s endurance testing and PVT testing and conclusions for each system.

b. Endurance testing for each system.

c. Completed PVT Plan for each system used during testing that includes hand written field notes and participant signatures.

d. Blank PVT Plan for each system approved prior to testing that is edited to reflect changes occurring during testing. Edits must be typed and must reflect changes to control sequences from contract documents, must reflect changes to numbered test methods required to initiate a response, and must reflect changes to expected response. Only one blank PVT Plan is required for each set of systems sharing an identical control sequence, such as air terminal units, exhaust air fans, fan coil units and unit heaters.

e. Written certification that the installation and testing of all systems are complete and meet all contract document requirements.

3.8 OPERATION AND MAINTENANCE (O&M) INSTRUCTIONS

Provide HVAC control System Operation and Maintenance Instructions which include:

a. "Data Package 3" as indicated in Section 01 78 23 OPERATION AND MAINTENANCE DATA for each piece of control equipment.

b. "Data Package 4" as described in Section 01 78 23 OPERATION AND MAINTENANCE DATA for all air compressors.

c. HVAC control system sequences of operation formatted as indicated.

d. Procedures for the HVAC system start-up, operation and shut-down including the manufacturer's supplied procedures for each piece of equipment, and procedures for the overall HVAC system.

e. As-built HVAC control system detail drawings formatted as indicated.

f. Routine maintenance checklist. Provide the routine maintenance checklist arranged in a columnar format, where the first column lists all installed devices, the second column states the maintenance activity or that no maintenance required, the third column states the frequency of the maintenance activity, and the fourth column is used for additional comments or reference.

g. Qualified service organization list, including at a minimum company name, contact name and phone number.

h. Start-Up Testing Report.

i. Performance Verification Test (PVT) Procedures and Report.

Submit 2 copies of the Operation and Maintenance Instructions, indexed and in booklet form. The Operation and Maintenance Instructions may be submitted as a Technical Data Package.

3.9 MAINTENANCE AND SERVICE

Provide services, materials and equipment as necessary to maintain the entire system in an operational state as indicated for a period of one year after successful completion and acceptance of the Performance Verification Test. Minimize impacts on facility operations.

a. The integration of the system specified in this section into a Utility Monitoring and Control System must not, of itself, void the warranty or otherwise alter the requirement for the one year maintenance and service period. Integration into a UMCS includes but is not limited to establishing communication between devices in the control system and the front end or devices in another system.

b. The changing of configuration properties must not, of itself, void the warranty or otherwise alter the requirement for the one year maintenance and service period.

3.9.1 Description of Work

Provide adjustment and repair of the system including the manufacturer's required sensor and actuator (including transducer) calibration, span and range adjustment.

3.9.2 Personnel

Use only service personnel qualified to accomplish work promptly and satisfactorily. Advise the Government in writing of the name of the designated service representative, and of any changes in personnel.

3.9.3 Scheduled Inspections

Perform two inspections at six-month intervals and provide work required. Perform inspections in June and December. During each inspection perform the indicated tasks:

a. Perform visual checks and operational tests of equipment.

b. Clean control system equipment including interior and exterior

surfaces.

c. Check and calibrate each field device. Check and calibrate 50 percent of the total analog inputs and outputs during the first inspection. Check and calibrate the remaining 50 percent of the analog inputs and outputs during the second major inspection. Certify analog test instrumentation accuracy to be twice the specified accuracy of the device being calibrated. Randomly check at least 25 percent of all binary inputs and outputs for proper operation during the first inspection. Randomly check at least 25 percent of the remaining binary inputs and outputs during the second inspection. If more than 20 percent of checked inputs or outputs failed the calibration check during any inspection, check and recalibrate all inputs and outputs during that inspection.

d. Run system software diagnostics and correct diagnosed problems.

e. Resolve any previous outstanding problems.

3.9.4 Scheduled Work

This work must be performed during regular working hours, Monday through Friday, excluding Federal holidays.

3.9.5 Emergency Service

The Government will initiate service calls when the system is not functioning properly. Qualified personnel must be available to provide service to the system. A telephone number where the service supervisor can be reached at all times must be provided. Service personnel must be at the site within 24 hours after receiving a request for service. The control system must be restored to proper operating condition as required per Section 01 78 00 CLOSEOUT SUBMITTALS.

3.9.6 Operation

After performing scheduled adjustments and repairs, verify control system operation as demonstrated by the applicable tests of the performance verification test.

3.9.7 Records and Logs

Keep dated records and logs of each task, with cumulative records for each major component, and for the complete system chronologically. Maintain a continuous log for all devices, including initial analog span and zero calibration values and digital points. Keep complete logs and provide logs for inspection onsite, demonstrating that planned and systematic adjustments and repairs have been accomplished for the control system.

3.9.8 Work Requests

Record each service call request as received and include its location, date and time the call was received, nature of trouble, names of the service personnel assigned to the task, instructions describing what has to be done, the amount and nature of the materials to be used, the time and date work started, and the time and date of completion. Submit a record of the work performed within 5 days after work is accomplished.

3.9.9 System Modifications

Submit recommendations for system modification in writing. Do not make system modifications, including operating parameters and control settings, without prior approval of the Government.

3.10 TRAINING

Conduct a training course for 4 operating staff members designated by the Government in the maintenance and operation of the system, including specified hardware and software. Conduct 32 hours of training at the project site within 30 days after successful completion of the performance verification test. The Government reserves the right to make audio and visual recordings (using Government supplied equipment)of the training sessions for later use. Provide audiovisual equipment and other training materials and supplies required to conduct training. A training day is defined as 8 hours of classroom instruction, including two 15 minute breaks and excluding lunchtime, Monday through Friday, during the daytime shift in effect at the training facility.

3.10.1 Training Documentation

Prepare training documentation consisting of:

a. Course Attendee List: Develop the list of course attendees in coordination with and signed by the Controls shop supervisor.

b. Training Manuals: Provide training manuals which include an agenda, defined objectives for each lesson, and a detailed description of the subject matter for each lesson. When presenting portions of the course material by audiovisuals, deliver copies of those audiovisuals as a part of the printed training manuals.

3.10.2 Training Course Content

For guidance in planning the required instruction, assume that attendees will have a high school education, and are familiar with HVAC systems. During the training course, cover all of the material contained in the Operating and Maintenance Instructions, the layout and location of each controller enclosure, the layout of one of each type of equipment and the locations of each, the location of each control device external to the panels, the location of the compressed air station, preventive maintenance, troubleshooting, diagnostics, calibration, adjustment, commissioning, tuning, and repair procedures. Typical systems and similar systems may be treated as a group, with instruction on the physical layout of one such system. Present the results of the performance verification test and the Start-Up Testing Report as benchmarks of HVAC control system performance by which to measure operation and maintenance effectiveness.

3.10.3 Training Documentation Submittal Requirements

Submit hardcopy training manuals and all training materials on CD-ROM. Provide one hardcopy manual for each trainee on the Course Attendee List and 2 additional copies for archive at the project site. Provide 2 copies of the Course Attendee List with the archival copies. Training Documentation may be submitted as a Technical Data Package.

APPENDIX A

QC CHECKLIST FOR NIAGARA FRAMEWORK BASED LONWORKS SYSTEMS		
This checklist is not all-inclusive of the requirements of this specification and should not be interpreted as such. Instructions: Initial each item in the space provided (|____|) verifying that the requirement has been met.		
This checklist is for (circle one:) Pre-Construction QC Checklist Submittal Post-Construction QC Checklist Submittal Close-out QC Checklist Submittal		
Items verified for Pre-Construction, Post-Construction and Closeout QC Checklist Submittals:		
1	All DDC Hardware is numbered on Control System Schematic Drawings.	|____|
2	Signal lines on Control System Schematic are labeled with the signal type.	|____|
3	Local Display Panel (LDP) Locations are shown on Control System Schematic drawings.	|____|
Items verified for Post-Construction and Closeout QC Checklist Submittals:		
4	All sequences are performed as specified using DDC Hardware.	|____|
5	Training schedule and course attendee list has been developed and coordinated with shops and submitted.	|____|
6	All DDC Hardware except Niagara Framework Supervisory Gateways is installed on a TP/FT-10 Channel.	|____|
7	All Application Specific Controllers (ASCs) are LonMark certified.	|____|
8	Except for communication between two Niagara Framework Supervisory Gateways, Communication between DDC Hardware is only via CEA-709.1-D using SNVTs. Other protocols have not been used. Network variables other than SNVTs have not been used. Communication between Niagara Framework Supervisory Gateways is via Fox Protocol.	|____|
9	Explicit messaging has not been used.	|____|

	QC CHECKLIST FOR NIAGARA FRAMEWORK BASED LONWORKS SYSTEMS	
10	Scheduling is performed in Niagara Framework Supervisory Gateways.	|____|
Items verified for Closeout QC Checklist Submittal:		
11	Final As-built Drawings, including all Points Schedule drawings, accurately represent the final installed system.	|____|
12	Programming software has been submitted for all programmable controllers.	|____|
13	All software has been licensed to the Government.	
14	O&M Instructions have been completed and submitted.	|____|
15	Training course has been completed.	|____|
16	The database in each Niagara Framework Supervisory Gateway is up-to-date and accurately represents the building control network beneath that Niagara Framework Supervisory Gateway.	|____|
17	Niagara Wizards have been submitted for all Application Specific Controllers (ASCs) for which a Wizard is available and for all Application Generic Controllers (AGCs).	|____|
18	Programming software has been submitted for all General Purpose Programmable Controllers (GPPCs) and all Application Generic Controllers (AGCs).	|____|
	_____ _____	
	(QC Representative Signature) (Date)	

-- End of Section --

SECTION 23 09 13

INSTRUMENTATION AND CONTROL DEVICES FOR HVAC
11/15

PART 1 GENERAL

1.1 SUMMARY

This section provides for the instrumentation control system components excluding direct digital controllers, network controllers, gateways etc. that are necessary for a completely functional automatic control system. When combined with a Direct Digital Control (DDC) system, the Instrumentation and Control Devices covered under this section must be a complete system suitable for the control of the heating, ventilating and air conditioning (HVAC) and other building-level systems as specified and indicated.

a. Install hardware to perform the control sequences as specified and indicated and to provide control of the equipment as specified and indicated.

b. Install hardware such that individual control equipment can be replaced by similar control equipment from other equipment manufacturers with no loss of system functionality.

c. Install and configure hardware such that the Government or their agents are able to perform repair, replacement, and upgrades of individual hardware without further interaction with the installing Contractor.

1.1.1 Verification of Dimensions

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

1.1.2 Drawings

The Government will not indicate all offsets, fittings, and accessories that may be required on the drawings. Carefully investigate the mechanical, electrical, and finish conditions that could affect the work to be performed, arrange such work accordingly, and provide all work necessary to meet such conditions.

1.2 RELATED SECTIONS

Related work specified elsewhere.

Section 01 30 00 ADMINISTRATIVE REQUIREMENTS

Section 23 00 00 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEMS

Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC

Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM

1.3 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC. (AMCA)

AMCA 500-D	(2018) Laboratory Methods of Testing Dampers for Rating
AMCA 511	(2010) Certified Ratings Program for Air Control Devices

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C12.1	((2014; Errata 2016) Electric Meters - Code for Electricity Metering

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.15	(2018) Cast Copper Alloy Threaded Fittings Classes 125 and 250
ASME B16.34	(2017) Valves - Flanged, Threaded and Welding End
ASME B40.100	(2013) Pressure Gauges and Gauge Attachments

ASTM INTERNATIONAL (ASTM)

ASTM A536	(1984; R 2019; E 2019) Standard Specification for Ductile Iron Castings

FLUID CONTROLS INSTITUTE (FCI)

FCI 70-2	(2013) Control Valve Seat Leakage

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 142	(2007; Errata 2014) Recommended Practice for Grounding of Industrial and Commercial Power Systems - IEEE Green Book

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI C12.20	(2015; E 2018) Electricity Meters - 0.1, 0.2, and 0.5 Accuracy Classes
NEMA 250	(2018) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA/ANSI C12.10	(2011) Physical Aspects of Watthour Meters - Safety Standards

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2020; ERTA 20-1 2020; ERTA 20-2 2020; TIA

	20-1; TIA 20-2; TIA 20-3; TIA 20-4) National Electrical Code
NFPA 90A	(2018) Standard for the Installation of Air Conditioning and Ventilating Systems

UNDERWRITERS LABORATORIES (UL)

UL 555	(2006; Reprint Aug 2016) UL Standard for Safety Fire Dampers
UL 555S	(2014; Reprint Aug 2016) UL Standard for Safety Smoke Dampers
UL 5085-3	(2006; Reprint Nov 20121) Low Voltage Transformers - Part 3: Class 2 and Class 3 Transformers

1.4 SUBMITTALS

Submittal requirements are specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

1.5 DELIVERY AND STORAGE

Store and protect products from the weather, humidity, and temperature variations, dirt and dust, and other contaminants, within the storage condition limits published by the equipment manufacturer.

1.6 INPUT MEASUREMENT ACCURACY

Select, install and configure sensors, transmitters and DDC Hardware such that the maximum error of the measured value at the input of the DDC hardware is less than the maximum allowable error specified for the sensor or instrumentation.

1.7 SUBCONTRACTOR SPECIAL REQUIREMENTS

Perform all work in this section in accordance with the paragraph entitled CONTRACTOR SPECIAL REQUIREMENTS in Section 01 30 00 ADMINISTRATIVE REQUIREMENTS.

PART 2 PRODUCTS

2.1 EQUIPMENT

2.1.1 General Requirements

All products used to meet this specification must meet the indicated requirements, but not all products specified here will be required by every project. All products must meet the requirements both Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC and this Section.

2.1.2 Operation Environment Requirements

Unless otherwise specified, provide products rated for continuous operation under the following conditions:

2.1.2.1 Pressure

Pressure conditions normally encountered in the installed location.

2.1.2.2 Vibration

Vibration conditions normally encountered in the installed location.

2.1.2.3 Temperature

a. Products installed indoors: Ambient temperatures in the range of 32 to 112 degrees F and temperature conditions outside this range normally encountered at the installed location.

b. Products installed outdoors or in unconditioned indoor spaces: Ambient temperatures in the range of -35 to +151 degrees F and temperature conditions outside this range normally encountered at the installed location.

2.1.2.4 Humidity

10 to 95 percent relative humidity, non-condensing and also humidity conditions outside this range normally encountered at the installed location.

2.2 WEATHERSHIELDS

Provide weathershields constructed of galvanized steel painted white, unpainted aluminum, aluminum painted white, or white PVC.

2.3 WIRE AND CABLE

Provide wire and cable meeting the requirements of NFPA 70 and NFPA 90A in addition to the requirements of this specification and referenced specifications.

2.3.1 Terminal Blocks

For terminal blocks which are not integral to other equipment, provide terminal blocks which are insulated, modular, feed-through, clamp style with recessed captive screw-type clamping mechanism, suitable for DIN rail mounting, and which have enclosed sides or end plates and partition plates for separation.

2.3.2 Control Wiring for Binary Signals

For Control Wiring for Binary Signals, provide 18 AWG copper or thicker wire rated for 300-volt service.

2.3.3 Control Wiring for Analog Signals

For Control Wiring for Analog Signals, provide 18 AWG or thicker, copper, single- or multiple-twisted wire meeting the following requirements:

a. minimum 2 inch lay of twist

b. 100 percent shielded pairs

c. at least 300-volt insulation

d. each pair has a 20 AWG tinned-copper drain wire and individual overall pair insulation

e. cables have an overall aluminum-polyester or tinned-copper cable-shield tape, overall 20 AWG tinned-copper cable drain wire, and overall cable insulation.

2.3.4 Power Wiring for Control Devices

For 24-volt circuits, provide insulated copper 18 AWG or thicker wire rated for 300 VAC service. For 120-volt circuits, provide 14 AWG or thicker stranded copper wire rated for 600-volt service.

2.3.5 Transformers

Provide UL 5085-3 approved transformers. Select transformers sized so that the connected load is no greater than 80 percent of the transformer rated capacity.

2.4 AUTOMATIC CONTROL VALVES

Provide valves with stainless-steel stems and stuffing boxes with extended necks to clear the piping insulation. Provide valves with bodies meeting ASME B16.34 or ASME B16.15 pressure and temperature class ratings based on the design operating temperature and 150 percent of the system design operating pressure. Unless otherwise specified or indicated, provide valves meeting FCI 70-2 Class III leakage rating. Provide valves rated for modulating or two-position service as indicated, which close against a differential pressure indicated as the Close-Off pressure and which are Normally-Open, Normally-Closed, or Fail-In-Last-Position as indicated.

2.4.1 Valve Type

2.4.1.1 Liquid Service 150 Degrees F or Less

Use either globe valves or ball valves except that butterfly valves may be used for sizes 4 inch and larger.

2.4.1.2 Liquid Service Above 150 Degrees F

a. Two-position valves: Use either globe valves or ball valves except that butterfly valves may be used for sizes 4 inch and larger.

b. Modulating valves: Use globe valves except that butterfly valves may be used for sizes 4 inch and larger.

2.4.1.3 Steam Service

Use globe valves except that butterfly valves may be used for sizes 4 inch and larger.

2.4.2 Valve Flow Coefficient and Flow Characteristic

2.4.2.1 Two-Way Modulating Valves

Provide the valve coefficient (Cv) indicated. Provide equal-percentage flow characteristic for liquid service except for butterfly valves. Provide linear flow characteristic for steam service except for butterfly

valves.

2.4.2.2 Three-Way Modulating Valves

Provide the valve coefficient (Cv) indicated. Provide linear flow characteristic with constant total flow throughout full plug travel.

2.4.3 Two-Position Valves

Use full line size full port valves with maximum available (Cv).

2.4.4 Globe Valves

2.4.4.1 Liquid Service Not Exceeding 150 Degrees F

a. Valve body and body connections:

(1) valves 1-1/2 inches and smaller: brass or bronze body, with threaded or union ends

(2) valves from 2 inches to 3 inches inclusive: brass, bronze, or iron bodies. 2 inch valves with threaded connections; 2-1/2 to 3 inches valves with flanged connections

b. Internal valve trim: Brass or bronze.

c. Stems: Stainless steel.

d. Provide valves compatible with a solution of 50 percent ethylene or propylene glycol.

2.4.4.2 Liquid Service Not Exceeding 250 Degrees F

a. Valve body and body connections:

(1) valves 1-1/2 inches and smaller: brass or bronze body, with threaded or union ends

(2) valves from 2 inches to 3 inches inclusive: brass, bronze, or iron bodies. 2 inch valves with threaded connections; 2-1/2 to 3 inches valves with flanged connections

b. Internal trim: Type 316 stainless steel including seats, seat rings, modulation plugs, valve stems, and springs.

c. Provide valves with non-metallic parts suitable for a minimum continuous operating temperature of 250 degrees F or 50 degrees F above the system design temperature, whichever is higher.

d. Provide valves compatible with a solution of 50 percent ethylene or propylene glycol

2.4.4.3 Hot water service 250 Degrees F and above

a. Provide valve bodies conforming to ASME B16.34 Class 300. For valves 1 inch and larger provide valves with bodies which are carbon steel, globe type with welded ends. For valves smaller than 1 inch provide valves with socket-weld ends. Provide valves with virgin polytetrafluoroethylene (PTFE) packing. Provide valve and actuator

combinations which are normally closed.

b. Internal trim: Type 316 stainless steel including seats, seat rings, modulation plugs, valve stems, and springs.

2.4.4.4 Steam Service

For steam service, provide valves meeting the following requirements:

a. Valve body and connections:

(1) valves 1-1/2 inches and smaller: complete body of brass or bronze, with threaded or union ends

(2) valves from 2 inches to 3 inches inclusive: body of brass, bronze, or carbon steel

(3) valves 4 inches and larger: body of carbon steel. 2 inch valves with threaded connections; valves2-1/2 inches and larger with flanged connections.

b. Internal Trim: Type 316 stainless steel including seats, seat rings, modulation plugs, valve stems, and springs.

c. Valve sizing: sized for 15 psig inlet steam pressure with a maximum 12 psi differential through the valve at rated flow, except where indicated otherwise.

2.4.5 Ball Valves

2.4.5.1 Liquid Service Not Exceeding 150 Degrees F

a. Valve body and connections:

(1) valves 1-1/2 inches and smaller: bodies of brass or bronze, with threaded or union ends

(2) valves from 2 inches to 3 inches inclusive: bodies of brass, bronze, or iron. 2 inch valves with threaded connections; valves from 2-1/2 to 3 inches with flanged connections.

b. Ball: Stainless steel or nickel-plated brass or chrome-plated brass.

c. Seals: Reinforced Teflon seals and EPDM O-rings.

d. Stem: Stainless steel, blow-out proof.

e. Provide valves compatible with a solution of 50 percent ethylene or propylene glycol.

2.4.6 Butterfly Valves

Provide butterfly valves which are threaded lug type suitable for dead-end service and modulation to the fully-closed position, with carbon-steel bodies or with ductile iron bodies in accordance with ASTM A536. Provide butterfly valves with non-corrosive discs, stainless steel shafts supported by bearings, and EPDM seats suitable for temperatures from -20 to +250 degrees F. Provide valves with rated Cv of the Cv at 70 percent (60 degrees) open position. Provide valves meeting FCI 70-2 Class VI

leakage rating.

2.4.7 Pressure Independent Control Valves (PICV)

Provide pressure independent control valves which include a regulator valve which maintains the differential pressure across a flow control valve. Pressure independent control valves must accurately control the flow from 0-100 percent full rated flow regardless of changes in the piping pressure and not vary the flow more than plus or minus 5 percent at any given flow control valve position when the PICV differential pressure lies between the manufacturer's stated minimum and maximum. The rated minimum differential pressure for steady flow must not exceed 5 psid across the PICV. Provide either globe or ball type valves meeting the indicated requirements for globe and ball valves. Provide valves with a flow tag listing full rated flow and minimum required pressure drop. Provide valves with factory installed Pressure/Temperature ports ("Pete's Plugs") to measure the pressure drop to determine the valve flow rate.

2.4.8 Duct-Coil and Terminal-Unit-Coil Valves

For duct or terminal-unit coils provide control valves with either flare-type, screw type, or solder-type ends. Provide flare nuts for each flare-type end valve.

2.5 DAMPERS

2.5.1 Damper Assembly

Provide single damper sections with blades no longer than 48 inches and which are no higher than 72 inches and damper blade width of 8 inches or less. When larger sizes are required, combine damper sections. Provide dampers made of steel, or other materials where indicated and with assembly frames constructed of 0.07 inch minimum thickness galvanized steel channels with mitered and welded corners. Steel channel frames constructed of 0.06 inch minimum thickness are acceptable provided the corners are reinforced.

a. Flat blades must be made rigid by folding the edges. Blade-operating linkages must be within the frame so that blade-connecting devices within the same damper section must not be located directly in the air stream.

b. Damper axles must be 1/2 inch minimum, plated steel rods supported in the damper frame by stainless steel or bronze bearings. Blades mounted vertically must be supported by thrust bearings.

c. Provide dampers which do not exceed a pressure drop through the damper of 0.04 inches water gauge at 1000 ft/min in the wide-open position. Provide dampers with frames not less than 2 inch in width. Provide dampers which have been tested in accordance with AMCA 500-D.

2.5.2 Operating Linkages

For operating links external to dampers, such as crank arms, connecting rods, and line shafting for transmitting motion from damper actuators to dampers, provide links able to withstand a load equal to at least 300 percent of the maximum required damper-operating force without deforming. Rod lengths must be adjustable. Links must be brass, bronze, zinc-coated steel, or stainless steel. Working parts of joints and clevises must be

brass, bronze, or stainless steel. Adjustments of crank arms must control the open and closed positions of dampers.

2.5.3 Damper Types

2.5.3.1 Flow Control Dampers

Provide parallel-blade or opposed blade type dampers for outside air, return air, relief air, exhaust, face and bypass dampers as indicated on the Damper Schedule. Blades must have interlocking edges. The channel frames of the dampers must be provided with jamb seals to minimize air leakage. Unless otherwise indicated, dampers must meet AMCA 511 Class 1A requirements. Outside air damper seals must be suitable for an operating temperature range of -40 to +167 degrees F. Dampers must be rated at not less than 2000 ft/min air velocity.

2.5.3.2 Mechanical Rooms and Other Utility Space Ventilation Dampers

Provide utility space ventilation dampers as indicated. Unless otherwise indicated provide AMCA 511 class 3 dampers. Provide dampers rated at not less than 1500 ft/min air velocity.

2.5.3.3 Smoke Dampers

Provide smoke-damper and actuator assemblies which meet the current requirements of NFPA 90A, UL 555, and UL 555S. For combination fire and smoke dampers provide dampers rated for 250 degrees F Class II leakage per UL 555S.

2.6 SENSORS AND INSTRUMENTATION

Unless otherwise specified, provide sensors and instrumentation which incorporate an integral transmitter. Sensors and instrumentation, including their transmitters, must meet the specified accuracy and drift requirements at the input of the connected DDC Hardware's analog-to-digital conversion.

2.6.1 Analog and Binary Transmitters

Provide transmitters which match the characteristics of the sensor. Transmitters providing analog values must produce a linear 4-20 mAdc, 0-10 Vdc signal corresponding to the required operating range and must have zero and span adjustment. Transmitters providing binary values must have dry contacts rated at 1A at 24 Volts AC.

2.6.2 Network Transmitters

Sensors and Instrumentation incorporating an integral network connection are considered DDC Hardware and must meet the DDC Hardware requirements of Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS when used in a Lonworks network.

2.6.3 Temperature Sensors

Provide the same sensor type throughout the project. Temperature sensors may be provided without transmitters. Where transmitters are used, the range must be the smallest available from the manufacturer and suitable for the application such that the range encompasses the expected range of temperatures to be measured. The end to end accuracy includes the

combined effect of sensitivity, hysteresis, linearity and repeatability between the measured variable and the end user interface (graphic presentation) including transmitters if used.

2.6.3.1 Sensor Accuracy and Stability of Control

2.6.3.1.1 Conditioned Space Temperature

Plus or minus 0.5 degree F over the operating range.

2.6.3.1.2 Unconditioned Space Temperature

a. Plus or minus 1 degree F over the range of 30 to 131 degrees F AND

b. Plus or minus 4 degrees F over the rest of the operating range.

2.6.3.1.3 Duct Temperature

Plus or minus 0.5 degree F

2.6.3.1.4 Outside Air Temperature

a. Plus or minus 2 degrees F over the range of -30 to +130 degrees F AND

b. Plus or minus 1 degree F over the range of 30 to 130 degrees F.

2.6.3.1.5 High Temperature Hot Water

Plus or minus 3.6 degrees F.

2.6.3.1.6 Chilled Water

Plus or minus 0.8 degrees F over the range of 35 to 65 degrees F.

2.6.3.1.7 Dual Temperature Water

Plus or minus 2 degrees F.

2.6.3.1.8 Heating Hot Water

Plus or minus 2 degrees F.

2.6.3.1.9 Condenser Water

Plus or minus 2 degrees F.

2.6.3.2 Transmitter Drift

The maximum allowable transmitter drift: 0.25 degrees F per year.

2.6.3.3 Point Temperature Sensors

Point Sensors must be encapsulated in epoxy, series 300 stainless steel, anodized aluminum, or copper.

2.6.3.4 Temperature Sensor Details

2.6.3.4.1 Room Type

Provide the sensing element components within a decorative protective cover suitable for surrounding decor.

2.6.3.4.2 Duct Probe Type

Ensure the probe is long enough to properly sense the air stream temperature.

2.6.3.4.3 Duct Averaging Type

Continuous averaging sensors must be one foot in length for each 1 square foot of duct cross-sectional area, and a minimum length of 5 feet.

2.6.3.4.4 Pipe Immersion Type

Provide minimum 3 inch immersion. Provide each sensor with a corresponding pipe-mounted sensor well, unless indicated otherwise. Sensor wells must be stainless steel when used in steel piping, and brass when used in copper piping.

2.6.3.4.5 Outside Air Type

Provide the sensing element rated for outdoor use

2.6.4 Relative Humidity Sensor

Relative humidity sensors must use bulk polymer resistive or thin film capacitive type non-saturating sensing elements capable of withstanding a saturated condition without permanently affecting calibration or sustaining damage. The sensors must include removable protective membrane filters. Where required for exterior installation, sensors must be capable of surviving below freezing temperatures and direct contact with moisture without affecting sensor calibration. When used indoors, the sensor must be capable of being exposed to a condensing air stream (100 percent relative humidity) with no adverse effect to the sensor's calibration or other harm to the instrument. The sensor must be of the wall-mounted or duct-mounted type, as required by the application, and must be provided with any required accessories. Sensors used in duct high-limit applications must have a bulk polymer resistive sensing element. Duct-mounted sensors must be provided with a duct probe designed to protect the sensing element from dust accumulation and mechanical damage. Relative humidity (RH) sensors must measure relative humidity over a range of 0 percent to 100 percent with an accuracy of plus or minus 2 percent. RH sensors must function over a temperature range of 40 to 135 degrees F and must not drift more than 1 percent per year.

2.6.5 Carbon Dioxide (CO2) Sensors

Provide photometric type CO2 sensors with integral transducers and linear output. Carbon dioxide (CO2) sensors must measure CO2 concentrations between 0 to 2000 parts per million (ppm) using non-dispersible infrared (NDIR) technology with an accuracy of plus or minus 50 ppm and a maximum response time of 1 minute. The sensor must be rated for operation at ambient air temperatures within the range of 32 to 122 degrees F and relative humidity within the range of 20 to 95 percent (non-condensing).

The sensor must have a maximum drift of 2 percent per year. The sensor chamber must be manufactured with a non-corrosive material that does not affect carbon dioxide sample concentration. Duct mounted sensors must be provided with a duct probe designed to protect the sensing element from dust accumulation and mechanical damage. The sensor must have a calibration interval no less than 5 years.

2.6.6 Differential Pressure Instrumentation

2.6.6.1 Differential Pressure Sensors

Provide Differential Pressure Sensors with ranges as indicated or as required for the application. Pressure sensor ranges must not exceed the high end range indicated on the Points Schedule by more than 50 percent. The over pressure rating must be a minimum of 150 percent of the highest design pressure of either input to the sensor. The accuracy must be plus or minus 1 percent of full scale. The sensor must have a maximum drift of 2 percent per year

2.6.6.2 Differential Pressure Switch

Provide differential pressure switches with a user-adjustable setpoint which are sized for the application such that the setpoint is between 25 percent and 75 percent of the full range. The over pressure rating must be a minimum of 150 percent of the highest design pressure of either input to the sensor. The switch must have two sets of contacts and each contact must have a rating greater than it's connected load. Contacts must open or close upon rise of pressure above the setpoint or drop of pressure below the setpoint as indicated.

2.6.7 Flow Sensors

2.6.7.1 Airflow Measurement Array (AFMA)

2.6.7.1.1 Airflow Straightener

Provide AFMAs which contain an airflow straightener if required by the AFMA manufacturer's published installation instructions. The straightener must be contained inside a flanged sheet metal casing, with the AFMA located as specified according to the published recommendation of the AFMA manufacturer. In the absence of published documentation, provide airflow straighteners if there is any duct obstruction within 5 duct diameters upstream of the AFMA. Air-flow straighteners, where required, must be constructed of 0.125 inch aluminum honeycomb and the depth of the straightener must not be less than 1.5 inches.

2.6.7.1.2 Resistance to Airflow

The resistance to air flow through the AFMA, including the airflow straightener must not exceed 0.085 inch water gauge at an airflow of 2,000 fpm. AFMA construction must be suitable for operation at airflows of up to 5000 fpm over a temperature range of 40 to 120 degrees F.

2.6.7.1.3 Outside Air Temperature

In outside air measurement or in low-temperature air delivery applications, provide an AFMA certified bythe manufacturer to be accurate as specified over a temperature range of -20 to +120 degrees F.

2.6.7.1.4 Pitot Tube AFMA

Each Pitot Tube AFMA must contain an array of velocity sensing elements. The velocity sensing elements must be of the multiple pitot tube type with averaging manifolds. The sensing elements must be distributed across the duct cross section in the quantity and pattern specified or recommended by the published installation instructions of the AFMA manufacturer.

a. Pitot Tube AFMAs for use in airflows over 600 fpm must have an accuracy of plus or minus 5 percent over a range of 500 to 2500 fpm.

b. Pitot Tube AFMAs for use in airflows under 600 fpm must have an accuracy of plus or minus 5 percent over a range of 125 to 2500 fpm.

2.6.7.1.5 Electronic AFMA

Each electronic AFMA must consist of an array of velocity sensing elements of the resistance temperature detector (RTD) or thermistor type. The sensing elements must be distributed across the duct cross section in the quantity and pattern specified or recommended by the published application data of the AFMA manufacturer. Electronic AFMAs must have an accuracy of plus or minus 5 percent over a range of 125 to 5,000 fpm and the output must be temperature compensated over a range of 32 to 212 degrees F.

2.6.7.1.6 Fan Inlet Measurement Devices

Fan inlet measurement devices cannot be used unless indicated on the drawings or schedules.

2.6.7.2 Orifice Plate

Orifice plate must be made of an austenitic stainless steel sheet of 0.125 inch nominal thickness with an accuracy of plus or minus 1 percent of full flow. The orifice plate must be flat within 0.002 inches. The orifice surface roughness must not exceed 20 micro-inches. The thickness of the cylindrical face of the orifice must not exceed 2 percent of the pipe inside diameter or 12.5 percent of the orifice diameter, whichever is smaller. The upstream edge of the orifice must be square and sharp. Where orifice plates are used, concentric orifice plates must be used in all applications except steam flow measurement in horizontal pipelines.

2.6.7.3 Flow Nozzle

Flow nozzle must be made of austenitic stainless steel with an accuracy of plus or minus 1 percent of full flow. The inlet nozzle form must be elliptical and the nozzle throat must be the quadrant of an ellipse. The thickness of the nozzle wall and flange must be such that distortion of the nozzle throat from strains caused by the pipeline temperature and pressure, flange bolting, or other methods of installing the nozzle in the pipeline must not cause the accuracy to degrade beyond the specified limit. The outside diameter of the nozzle flange or the design of the flange facing must be such that the nozzle throat must be centered accurately in the pipe.

2.6.7.4 Venturi Tube

Venturi tube must be made of cast iron or cast steel and must have an accuracy of plus or minus 1 percent of full flow. The throat section must be lined with austenitic stainless steel. Thermal expansion

characteristics of the lining must be the same as that of the throat casting material. The surface of the throat lining must be machined to a plus or minus 50 micro inch finish, including the short curvature leading from the converging entrance section into the throat.

2.6.7.5 Annular Pitot Tube

Annular pitot tube must be made of austenitic stainless steel with an accuracy of plus or minus 2 percent of full flow and a repeatability of plus or minus 0.5 percent of measured value. The unit must have at least one static port and no less than four total head pressure ports with an averaging manifold.

2.6.7.6 Insertion Turbine Flowmeter

Provide dual axial turbine flowmeter with all installation hardware necessary to enable insertion and removal of the meter without system shutdown. All parts must meet or exceed the pressure classification of the pipe system it is installed in. Insertion Turbine Flowmeter accuracy must be plus or minus 0.5 percent of rate at calibrated velocity., within plus or minus of rate over a 10:1 turndown and within plus or minus 2 percent of rate over a 50:1 turndown. Repeatability must be plus or minus 0.25 percent of reading. The meter flow sensing element must operate over a range suitable for the installed location with a pressure loss limited to 1 percent of operating pressure at maximum flow rate. The flowmeter ,must include either dry contact pulse outputs, 4-20mA, 0-10Vdc or 0-5Vdc outputs. The turbine rotor assembly must be constructed of Series 300 stainless steel and use Teflon seals.

2.6.7.7 Vortex Shedding Flowmeter

Vortex Shedding Flowmeter accuracy must be within plus or minus 0.8 percent of the actual reading over the range of the meter. Steam meters must contain density compensation by direct measurement of temperature. Mass flow inferred from specified steam pressure are not acceptable. The flow meter body must be made of austenitic stainless steel and include a weather tight NEMA 4X electronics enclosure. The vortex shedding flowmeter body must not require removal from the piping in order to replace the shedding sensor.

2.6.7.8 Ultrasonic Flow Meter

Provide Ultrasonic Flow Meters complete with matched transducers, self aligning installation hardware and transducer cables. Ultrasonic transducers must be optimized for the specific pipe and process conditions for the application. The flow meter accuracy must plus or minus 1 percent of rate from 0 to 40 ft/sec. The flowmeter must include either dry contact pulse outputs, 4-20mA, 0-10Vdc or 0-5Vdc output.

2.6.7.9 Insertion Magnetic Flow Meter

Provide insertion type magnetic flowmeters with all installation hardware necessary to enable insertion and removal of the meter without system shutdown. All parts must meet or exceed the pressure classification of the pipe system it is installed in. Flowmeter accuracy must be no greater than plus or minus 1 percent of rate from 2 to 20 feet/sec. Wetted material parts must be 300 series stainless steel. The flowmeter must include either dry contact pulse outputs, 4-20mA, 0-10Vdc or 0-5Vdc outputs.

2.6.7.10 Positive Displacement Flow Meter

The flow meter must be a direct reading, gerotor, nutating disc or vane type displacement device rated for liquid service as indicated. A counter must be mounted on top of the meter, and must consist of a non-resettable mechanical totalizer for local reading, and a pulse transmitter for remote reading. The totalizer must have a six digit register to indicate the volume passed through the meter in gallons, and a sweep-hand dial to indicate down to 0.25 gallons. The pulse transmitter must have a hermetically sealed reed switch which is activated by magnets fixed on gears of the counter. The meter must have a bronze body with threaded or flanged connections as required for the application. Output accuracy must be plus or minus 2 percent of the flow range. The maximum pressure drop at full flow must be 5 psig.

2.6.7.11 Flow Meters, Paddle Type

Sensor must be non-magnetic, with forward curved impeller blades designed for water containing debris. Sensor accuracy must be plus or minus 1 percent of rate of flow, minimum operating flow velocity must be 1 foot per second. Sensor repeatability and linearity must be plus or minus 1 percent. Materials which will be wetted must be made from non-corrosive materials and must not contaminate water. The sensor must be rated for installation in pipes of 3 to 40 inch diameters. The transmitter housing must be a NEMA 250 Type 4 enclosure.

2.6.7.12 Flow Switch

Flow switch must have a repetitive accuracy of plus or minus 10 percent of actual flow setting. Switch actuation must be adjustable over the operating flow range, and must be sized for the application such that the setpoint is between 25 percent and 75 percent of the full range.. The switch must have Form C snap-action contacts, rated for the application. The flow switch must have non flexible paddle with magnetically actuated contacts and be rated for service at a pressure greater than the installed conditions. Flow switch for use in sewage system must be rated for use in corrosive environments encountered.

2.6.7.13 Gas Flow Meter

~~Gas flow meter must be diaphragm or bellows type (gas positive displacement meters) for flows up to 2500 SCFH and axial flow turbine type for flows above 2500 SCFH, designed specifically for natural gas supply metering, and rated for the pressure, temperature, and flow rates of the installation. Meter must have a minimum turndown ratio of 10 to 1 with an accuracy of plus or minus 1 percent of actual flow rate. The meter index must include a direct reading mechanical totalizing register and electrical impulse dry contact output for remote monitoring. The electrical impulse dry contact output must not require field adjustment or calibration. The electrical impulse dry contact output must have a minimum resolution of 100 cubic feet of gas per pulse and must not exceed 15 pulses per second at the design flow.~~Refer to specification Section 23 11 20 for gas flow meter requirements.

2.6.8 Electrical Instruments

Provide Electrical Instruments with an input range as indicated or sized for the application. Unless otherwise specified, AC instrumentation must

be suitable for 60 Hz operation.

2.6.8.1 Current Transducers

Current transducers must accept an AC current input and must have an accuracy of plus or minus 0.5 percent of full scale. The device must have a means for calibration. Current transducers for variable frequency applications must be rated for variable frequency operation.

2.6.8.2 Current Sensing Relays (CSRs)

Current sensing relays (CSRs) must provide a normally-open contact with a voltage and amperage rating greater than its connected load. Current sensing relays must be of split-core design. The CSR must be rated for operation at 200 percent of the connected load. Voltage isolation must be a minimum of 600 volts. The CSR must auto-calibrate to the connected load or be adjustable and field calibrated. Current sensors for variable frequency applications must be rated for variable frequency operation.

2.6.8.3 Voltage Transducers

Voltage transducers must accept an AC voltage input and have an accuracy of plus or minus 0.25 percent of full scale. The device must have a means for calibration. Line side fuses for transducer protection must be provided.

2.6.8.4 Energy Metering

2.6.8.4.1 Watt or Watthour Transducers

Watt transducers must measure voltage and current and must output kW or kWh or both kW and kWh as indicated. kW outputs must have an accuracy of plus or minus 0.5 percent over a power factor range of 0.1 to 1. kWh outputs must have an accuracy of plus or minus 0.5 percent over a power factor range of 0.1 to 1.

2.6.8.4.2 Watthour Revenue Meter (with and without Demand Register)

All Watthour revenue meters must measure voltage and current and must be in accordance with ANSI C12.1 with an ANSI C12.20 Accuracy class of 0.5 and must have pulse initiators for remote monitoring of Watthour consumption. Pulse initiators must consist of form C contacts with a current rating not to exceed two amperes and voltage not to exceed 500 V, with combinations of VA not to exceed 100 VA, and a life rating of one billion operations. Meter sockets must be in accordance with NEMA/ANSI C12.10. Watthour revenue meters with demand registers must output instantaneous demand in addition to the pulse initiators.

2.6.8.4.3 Steam Meters

Steam meters must be the vortex type, with pressure compensation, a minimum turndown ratio of 10 to 1, and an output signal compatible with the DDC system.

2.6.8.4.4 Hydronic BTU Meters

The BTU meter is to be supplied with wall mount hardware and be capable of being installed remote from the flow meter. The BTU meter must include an LCD display for local indication of energy rate and for display of

parameters and settings during configuration. Each BTU meter must be factory configured for its specific application and be completely field configurable by the user via a front panel keypad (no special interface device or computer required). The unit must output Energy Rate, Energy Total, Flow Rate, Supply Temperature, and Return Temperature. An integral transmitter is to provide a linear analog or configurable pulse output signal representing the energy rate; and the signal must be compatible with building automation system DDC Hardware to which the output is connected.

2.6.9 pH Sensor

The sensor must be suitable for applications and chemicals encountered in water treatment systems of boilers, chillers and condenser water systems. Construction, wiring, fittings and accessories must be corrosion and chemical resistant with fittings for tank or suspension installation. Housing must be polyvinylidene fluoride with O-rings made of chemical resistant materials which do not corrode or deteriorate with extended exposure to chemicals. The sensor must be encapsulated. Periodic replacement must not be required for continued sensor operation. Sensors must use a ceramic junction and pH sensitive glass membrane capable of withstanding a pressure of 100 psig at 150 degrees F. The reference cell must be double junction configuration. Sensor range must be 0 to 12 pH, stability 0.05, sensitivity 0.02, and repeatability of plus or minus 0.05 pH value, response of 90 percent of full scale in one second and a linearity of 99 percent of theoretical electrode output measured at 76 degrees F.

2.6.10 Occupancy Sensors

Occupancy sensors must have occupancy-sensing sensitivity adjustment and an adjustable off-delay timer with a setpoint of 15 minutes. Adjustments accessible from the face of the unit are preferred. Occupancy sensors must be rated for operation in ambient air temperatures ranging from 40 to 95 degrees F or temperatures normally encountered in the installed location. Sensors integral to wall mount on-off light switches must have an auto-off switch. Wall switch sensors must be decorator style and must fit behind a standard decorator type wall plate. All occupancy sensors, power packs, and slave packs must be UL listed. In addition to any outputs required for lighting control, the occupancy sensor must provide an output for the HVAC control system.

2.6.10.1 Passive Infrared (PIR) Occupancy Sensors

PIR occupancy sensors must have a multi-level, multi-segmented viewing lens and a conical field of view with a viewing angle of 180 degrees and a detection of at least 20 feet unless otherwise indicated or specified. PIR Sensors must provide field-adjustable background light-level adjustment with an adjustment range suitable to the light level in the sensed area, room or space. PIR sensors must be immune to false triggering from RFI and EMI.

2.6.10.2 Ultrasonic Occupancy Sensors

Ultrasonic sensors must operate at a minimum frequency 32 kHz and must be designed to not interfere with hearing aids.

2.6.10.3 Dual-Technology Occupancy Sensor (PIR and Ultrasonic)

Dual-Technology Occupancy Sensors must meet the requirements of both PIR and Ultrasonic Occupancy Sensors.

2.6.11 Vibration Switch

Vibration switch must be solid state, enclosed in a NEMA 250 Type 4 or Type 4X housing with sealed wire entry. Unit must have two independent sets of Form C switch contacts with one set to shutdown equipment upon excessive vibration and a second set for monitoring alarm level vibration. The vibration sensing range must be a true rms reading, suitable for the application. The unit must include either displacement response for low speed or velocity response for high speed application. The frequency range must be at least 3 Hz to 500 Hz. Contact time delay must be 3 seconds. The unit must have independent start-up and running delay on each switch contact. Alarm limits must be adjustable and setpoint accuracy must be plus or minus 10 percent of setting with repeatability of plus or minus 2 percent.

2.6.12 Floor Mounted Leak Detector

Leak detectors must use electrodes mounted at slab level with a minimum built-in-vertical adjustment of 0.125 inches. Detector must have a binary output. The indicator must be manual reset type.

2.6.13 Temperature Switch

2.6.13.1 Duct Mount Temperature Low Limit Safety Switch (Freezestat)

Duct mount temperature low limit switches (Freezestats) must be manual reset, low temperature safety switches at least 1 foot long per square foot of coverage which must respond to the coldest 18 inch segment with an accuracy of plus or minus 3.6 degrees F. The switch must have a field-adjustable setpoint with a range of at least 30 to 50 degrees F. The switch must have two sets of contacts, and each contact must have a rating greater than its connected load. Contacts must open or close upon drop of temperature below setpoint as indicated and must remain in this state until reset.

2.6.13.2 Pipe Mount Temperature Limit Switch (Aquastat)

Pipe mount temperature limit switches (aquastats) must have a field adjustable setpoint between 60 and 90 degrees F, an accuracy of plus or minus 3.6 degrees F and a 10 degrees F fixed deadband. The switch must have two sets of contacts, and each contact must have a rating greater than its connected load. Contacts must open or close upon change of temperature above or below setpoint as indicated.

2.6.14 Damper End Switches

Each end switch must be a hermetically sealed switch with a trip lever and over-travel mechanism. The switch enclosure must be suitable for mounting on the duct exterior and must permit setting the position of the trip lever that actuates the switch. The trip lever must be aligned with the damper blade.

End switches integral to an electric damper actuator are allowed as long as at least one is adjustable over the travel of the actuator.

2.6.15 Air Quality Sensors

Provide full spectrum air quality sensors using a hot wire element based on the Taguchi principle. The sensor must monitor a wide range of gaseous volatile organic components common in indoor air contaminants like paint fumes, solvents, cigarette smoke, and vehicle exhaust. The sensor must automatically compensate for temperature and humidity, have span and calibration potentiometers, operate on 24 VDC power with output of 0-10 VDC, and have a service rating of 32 to 140 degrees F and 5 to 95 percent relative humidity.

2.7 INDICATING DEVICES

All indicating devices must display readings in English (inch-pound) units.

2.7.1 Thermometers

Provide bi-metal type thermometers at locations indicated. Thermometers must have either 9 inch long scales or 3.5 inch diameter dials, with insertion, immersion, or averaging elements. Provide matching thermowells for pipe-mounted installations. Select scale ranges suitable for the intended service, with the normal operating temperature near the scale's midpoint. The thermometer's accuracy must be plus or minus 2 percent of the scale range.

2.7.1.1 Piping System Thermometers

Piping system thermometers must have brass, malleable iron or aluminum alloy case and frame, clear protective face, permanently stabilized glass tube with indicating-fluid column, white face, black numbers, and a 9 inch scale. Piping system thermometers must have an accuracy of plus or minus 1 percent of scale range. Thermometers for piping systems must have rigid stems with straight, angular, or inclined pattern. Thermometer stems must have expansion heads as required to prevent breakage at extreme temperatures. On rigid-stem thermometers, the space between bulb and stem must be filled with a heat-transfer medium.

2.7.1.2 Air-Duct Thermometers

Air-duct thermometers must have perforated stem guards and 45-degree adjustable duct flanges with locking mechanism.

2.7.2 Pressure Gauges

Provide pipe-mounted pressure gauges at the locations indicated. Gauges must conform to ASME B40.100 and have a 4 inch diameter dial and shutoff cock. Select scale ranges suitable for the intended service, with the normal operating pressure near the scale's midpoint. The gauge's accuracy must be plus or minus 2 percent of the scale range.

Gauges must be suitable for field or panel mounting as required, must have black legend on white background, and must have a pointer traveling through a 270-degree arc. Gauge range must be suitable for the application with an upper end of the range not to exceed 150 percent of the design upper limit. Accuracy must be plus or minus 3 percent of scale range. Gauges must meet requirements of ASME B40.100.

2.7.3 Low Differential Pressure Gauges

Gauges for low differential pressure measurements must be a minimum of 3.5 inch (nominal) size with two sets of pressure taps, and must have a diaphragm-actuated pointer, white dial with black figures, and pointer zero adjustment. Gauge range must be suitable for the application with an upper end of the range not to exceed 150 percent of the design upper limit. Accuracy must be plus or minus two percent of scale range.

2.8 OUTPUT DEVICES

2.8.1 Actuators

Actuators must be electric (electronic). All actuators must be normally open (NO), normally closed (NC) or fail-in-last-position (FILP) as indicated. Normally open and normally closed actuators must be of mechanical spring return type. Electric actuators must have an electronic cut off or other means to provide burnout protection if stalled. Actuators must have a visible position indicator. Electric actuators must provide position feedback to the controller as indicated. Actuators must smoothly and fully open or close the devices to which they are applied. Electric actuators must have a full stroke response time in both directions of 90 seconds or less at rated load. Electric actuators must be of the foot-mounted type with an oil-immersed gear train or the direct-coupled type. Where multiple electric actuators operate from a common signal, the actuators must provide an output signal identical to its input signal to the additional devices. All actuators must be rated for their operating environment. Actuators used outdoors must be designed and rated for outdoor use. Actuators under continuous exposure to water, such as those used in sumps, must be submersible.

Actuators incorporating an integral network connection are considered DDC Hardware and must meet the DDC Hardware requirements of Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

2.8.1.1 Valve Actuators

Valve actuators must provide shutoff pressures and torques as indicated on the Valve Schedule.

2.8.1.2 Damper Actuators

Damper actuators must provide the torque necessary per damper manufacturer's instructions to modulate the dampers smoothly over its full range of operation and torque must be at least 6 inch-pounds/1 square foot of damper area for opposed blade dampers and 9 inch-pounds/1 square foot of damper area for parallel blade dampers.

2.8.1.3 Electric Actuators

Each actuator must have distinct markings indicating the full-open and full-closed position Each actuator must deliver the torque required for continuous uniform motion and must have internal end switches to limit the travel, or be capable of withstanding continuous stalling without damage. Actuators must function properly within 85 to 110 percent of rated line voltage. Provide actuators with hardened steel running shafts and gears of steel or copper alloy. Fiber or reinforced nylon gears may be used for torques less than 16 inch-pounds..

a. Two-position actuators must be single direction, spring return, or reversing type. Two position actuator signals may either be the control power voltage or line voltage as needed for torque or appropriate interlock circuits.

b. Modulating actuators must be capable of stopping at any point in the cycle, and starting in either direction from any point. Actuators must be equipped with a switch for reversing direction, and a button to disengage the clutch to allow manual adjustments. Provide the actuator with a hand crank for manual adjustments, as applicable. Modulating actuator input signals can either be a 4 to 20 mAdc or a 0-10 VDC signal.

c. Floating or pulse width modulation actuators are acceptable for non-fail safe applications unless indicated otherwise provided that the floating point control (timed actuation) must have a scheduled re-calibration of span and position no more than once a day and no less than once a week. The schedule for the re-calibration should not affect occupied conditions and be staggered between equipment to prevent falsely loading or unloading central plant equipment.

2.8.2 Relays

Relays must have contacts rated for the intended application, indicator light, and dust proof enclosure. The indicator light must be lit when the coil is energized and off when coil is not energized.

Control relay contacts must have utilization category and ratings selected for the application. Each set of contacts must incorporate a normally open (NO), normally closed (NC) and common contact. Relays must be rated for a minimum life of one million operations.

2.9 USER INPUT DEVICES

User Input Devices, including potentiometers, switches and momentary contact push-buttons. Potentiometers must be of the thumb wheel or sliding bar type. Momentary Contact Push-Buttons may include an adjustable timer for their output. User input devices must be labeled for their function.

2.10 MULTIFUNCTION DEVICES

Multifunction devices are products which combine the functions of multiple sensor, user input or output devices into a single product. Unless otherwise specified, the multifunction device must meet all requirements of each component device. Where the requirements for the component devices conflict, the multifunction device must meet the most stringent of the requirements.

2.10.1 Current Sensing Relay Command Switch

The Current Sensing Relay portion must meet all requirements of the Current Sensing Relay input device. The Command Switch portion must meet all requirements of the Relay output device except that it must have at least one normally-open (NO) contact.

Current Sensing Relays used for Variable Frequency Drives must be rated for Variable Frequency applications unless installed on the source side of

the drive. If used in this situation, the threshold for showing status must be set to allow for the VFD's control power when the drive is not enabled and provide indication of operation when the drive is enabled at minimum speed.

2.10.2 Space Sensor Module

Space Sensor Modules must be multifunction devices incorporating a temperature sensor and one or more of the following as specified and indicated on the Space Sensor Module Schedule:

a. A temperature indicating device.

b. A User Input Device which must adjust a temperature setpoint output.

c. A User Input Momentary Contact Button and an output to the control system indicating zone occupancy.

d. A three position User Input Switch labeled to indicate heating, cooling and off positions ('HEAT-COOL-OFF' switch) and providing corresponding outputs to the control system.

e. A two position User Input Switch labeled with 'AUTO' and 'ON' positions and providing corresponding output to the control system..

f. A multi-position User Input Switch with 'OFF' and at least two fan speed positions and providing corresponding outputs to the control system.

Space Sensor Modules cannot contain mercury (Hg).

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 General Installation Requirements

Perform the installation under the supervision of competent technicians regularly employed in the installation of DDC systems.

3.1.1.1 Device Mounting Criteria

All devices must be installed in accordance with manufacturer's recommendations and as specified and indicated. Control devices to be installed in piping and ductwork must be provided with required gaskets, flanges, thermal compounds, insulation, piping, fittings, and manual valves for shutoff, equalization, purging, and calibration. Strap-on temperature sensing elements must not be used except as specified. Spare thermowells must be installed adjacent to each thermowell containing a sensor and as indicated. Devices located outdoors must have a weathershield.

3.1.1.2 Labels and Tags

Match labels and tags to the unique identifiers indicated on the As-Built drawings. Label all enclosures and instrumentation. Tag all sensors and actuators in mechanical rooms. Tag airflow measurement arrays to show flow rate range for signal output range, duct size, and pitot tube AFMA flow coefficient. Tag duct static pressure taps at the location of the

pressure tap. Provide plastic or metal tags, mechanically attached directly to each device or attached by a metal chain or wire. Labels exterior to protective enclosures must be engraved plastic and mechanically attached to the enclosure or instrumentation. Labels inside protective enclosures may attached using adhesive, but must not be hand written.

3.1.2 Weathershield

Provide weathershields for sensors located outdoors. Install weathershields such that they prevent the sun from directly striking the sensor and prevent rain from directly striking or dripping onto the sensor. Install weather shields with adequate ventilation so that the sensing element responds to the ambient conditions of the surroundings. When installing weathershields near outside air intake ducts, install them such that normal outside air flow does not cause rainwater to strike the sensor.

3.1.3 Room Instrument Mounting

Mount room instruments, including but not limited to wall mounted non-adjustable space sensor modules and sensors located in occupied spaces, 48 inches above the floor unless otherwise indicated. Install adjustable devices to be ADA compliant unless otherwise indicated on the Room Sensor Schedule:

a. Space Sensor Modules for Fan Coil Units may be either unit or wall mounted but not mounted on an exterior wall.

b. Wall mount all other Space Sensor Modules.

3.1.4 Indication Devices Installed in Piping and Liquid Systems

Provide snubbers for gauges in piping systems subject to pulsation. For gauges for steam service use pigtail fittings with cock. Install thermometers and temperature sensing elements in liquid systems in thermowells. Provide spare Pressure/Temperature Ports (Pete's Plug) for all temperature and pressure sensing elements installed in liquid systems for calibration/testing.

3.1.5 Occupancy Sensors

Provide a sufficient quantity of occupancy sensors to provide complete coverage of the area (room or space). Occupancy sensors are to be ceiling mounted. Install occupancy sensors in accordance with NFPA 70 requirements and the manufacturer's instructions. Do not locate occupancy sensors within 6 feet of HVAC outlets or heating ducts, or where they can "see" beyond any doorway. Installation above doorway(s) is preferred. Do not use ultrasonic sensors in spaces containing ceiling fans. Install sensors to detect motion to within 2 feet of all room entrances and to not trigger due to motion outside the room. Set the off-delay timer to 15 minutes unless otherwise indicated. Adjust sensors prior to beneficial occupancy, but after installation of furniture systems, shelving, partitions, etc. For each controlled area, provide one hundred percent coverage capable of detecting small hand-motion movements, accommodating all occupancy habits of single or multiple occupants at any location within the controlled room.

3.1.6 Switches

3.1.6.1 Temperature Limit Switch

Provide a temperature limit switch (freezestat) to sense the temperature at the location indicated. Provide a sufficient number of temperature limit switches (freezestats) to provide complete coverage of the duct section but no less than 1 foot in length per square foot of cross sectional area. Install manual reset limit switches in approved, accessible locations where they can be reset easily. Install temperature limit switch (freezestat) sensing elements in a side-to-side (not top-to-bottom) serpentine pattern with the relay section at the highest point and in accordance with the manufacturer's installation instructions.

3.1.6.2 Hand-Off Auto Switches

Wire safety controls such as smoke detectors and freeze protection thermostats to protect the equipment during both hand and auto operation.

3.1.7 Temperature Sensors

Install temperature sensors in locations that are accessible and provide a good representation of sensed media. Installations in dead spaces are not acceptable. Calibrate and install sensors according to manufacturer’s instructions. Select sensors only for intended application as designated or recommended by manufacturer.

3.1.7.1 Room Temperature Sensors

Mount the sensors on interior walls to sense the average room temperature at the locations indicated. Avoid locations near heat sources such as copy machines or locations by supply air outlet drafts. Mount the center of all user-adjustable sensors at the heights indicated. Non user-adjustable sensors can be mounted as indicated in paragraph ROOM INSTRUMENT MOUNTING.

3.1.7.2 Duct Temperature Sensors

3.1.7.2.1 Probe Type

Place tip of the sensor in the middle of the airstream or in accordance with manufacturer's recommendations or instructions.Provide a gasket between the sensor housing and the duct wall. Seal the duct penetration air tight. When installed in insulated duct, provide enclosure or stand off fitting to accommodate the thickness of duct insulation to allow for maintenance or replacement of the sensor and wiring terminations. Seal the duct insulation penetration vapor tight.

3.1.7.2.2 Averaging Type

Weave the sensing element in a serpentine fashion from side to side perpendicular to the flow, across the duct or air handler cross-section, using durable non-metal supports in accordance with manufacturer's installation instructions. Avoid tight radius bends or kinking of the sensing element. Prevent contact between the sensing element and the duct or air handler internals. Provide a duct access door at the sensor location. The access door must be hinged on the side, factory insulated, have cam type locks, and be as large as the duct will permit, maximum 18 by 18 inches. For sensors inside air handlers, the sensors must be fully

accessible through the air handler's access doors without removing any of the air handler's internals.

3.1.7.3 Immersion Temperature Sensors

Provide thermowells for sensors measuring piping, tank, or pressure vessel temperatures. Locate wells to sense continuous flow conditions. Do not install wells using extension couplings. When installed on insulated piping, provide stand enclosure or stand off fitting to accommodate the thickness of the pipe insulation and allow for maintenance or replacement of the sensor or wiring terminations. Where piping diameters are smaller than the length of the wells, provide wells in piping at elbows to sense flow across entire area of well. Wells must not restrict flow area to less than 70 percent of pipe area. Increase piping size as required to avoid restriction. Provide the sensor well with a heat-sensitive transfer agent between the sensor and the well interior ensuring contact between the sensor and the well.

3.1.7.4 Outside Air Temperature Sensors

Provide outside air temperature sensors on the building's north side with a protective weather shade that does not inhibit free air flow across the sensing element, and protects the sensor from snow, ice, and rain. Location must not be near exhaust hoods and other areas such that it is not influenced by radiation or convection sources which may affect the reading. Provide a shield to shade the sensor from direct sunlight.

3.1.8 Air Flow Measurement Arrays (AFMA)

Locate Outside Air AFMAs downstream from the Outside Air filters.

Install AFMAs with the manufacturer's recommended minimum distances between upstream and downstream disturbances. Airflow straighteners may be used to reduce minimum distances as recommended by the AFMA manufacturer.

3.1.9 Duct Static Pressure Sensors

Locate the duct static pressure sensing tap at 75 percent of the distance between the first and last air terminal units. If the transmitter output is a 0-10Vdc signal, locate the transmitter in the same enclosure as the air handling unit (AHU) controller for the AHU serving the terminal units. If a remote duct static pressure sensor is to be used, run the signal wire back to the controller for the air handling unit.

3.1.10 Relative Humidity Sensors

Install relative humidity sensors in supply air ducts at least 10 feet downstream of humidity injection elements.

3.1.11 Meters

3.1.11.1 Flowmeters

Install flowmeters to ensure minimum straight unobstructed piping for at least 10 pipe diameters upstream and at least 5 pipe diameters downstream of the flowmeter, and in accordance with the manufacturer's installation instructions.

3.1.11.2 Energy Meters

Locate energy meters as indicated. Connect each meter output to the DDC system, to measure both instantaneous demand/energy and other variables as indicated.

3.1.12 Dampers

3.1.12.1 Damper Actuators

Provide spring return actuators which fail to a position that protects the served equipment and space on all control dampers related to freeze protection or force protection. For all outside, makeup and relief dampers provide dampers which fail closed. Terminal fan coil units, terminal VAV units, convectors, and unit heaters nay be non-spring return unless indicated otherwise. Do not mount actuators in the air stream. Do not connect multiple actuators to a common drive shaft. Install actuators so that their action seal the damper to the extent required to maintain leakage at or below the specified rate and so that they move the blades smoothly throughout the full range of motion.

3.1.12.2 Damper Installation

Install dampers straight and true, level in all planes, and square in all dimensions. Dampers must move freely without undue stress due to twisting, racking (parallelogramming), bowing, or other installation error. External linkages must operate smoothly over the entire range of motion, without deformation or slipping of any connecting rods, joints or brackets that will prevent a return to it's normal position. Blades must close completely and leakage must not exceed that specified at the rated static pressure. Provide structural support for multi-section dampers. Acceptable methods of structural support include but are not limited to U-channel, angle iron, corner angles and bolts, bent galvanized steel stiffeners, sleeve attachments, braces, and building structure. Where multi-section dampers are installed in ducts or sleeves, they must not sag due to lack of support. Do not use jackshafts to link more than three damper sections. Do not use blade to blade linkages. Install outside and return air dampers such that their blades direct their respective air streams towards each other to provide for maximum mixing of air streams.

3.1.13 Valves

Install the valves in accordance with the manufacturer's instructions.

3.1.13.1 Valve Actuators

Provide spring return actuators on all control valves where freeze protection is required. Spring return actuators for terminal fan coil units, terminal VAV units, convectors, and unit heaters are not required unless indicated otherwise.

3.1.14 Thermometers and Gauges

3.1.14.1 Thermometers

Mount devices to allow reading while standing on the floor or ground, as applicable.

3.1.15 Wire and Cable

Provide complete electrical wiring for the Control System, including wiring to transformer primaries. Wire and Cable must be installed without splices between control devices and in accordance with NFPA 70 and NFPA 90A. Instrumentation grounding must be installed per the device manufacturer's instructions and as necessary to prevent ground loops, noise, and surges from adversely affecting operation of the system. Test installed ground rods as specified in IEEE 142. Cables and conductor wires must be tagged at both ends, with the identifier indicated on the shop drawings. Electrical work must be as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM and as indicated. Wiring external to enclosures must be run in raceways, except low-voltage control and low-voltage network wiring may be installed as follows:

a. plenum rated cable in suspended ceilings over occupied spaces may be run without raceways

b. nonmetallic-sheathed cables or metallic-armored cables may be installed as permitted by NFPA 70.

Install control circuit wiring not in raceways in a neat and safe manner. Wiring must not use the suspended ceiling system (including tiles, frames or hangers) for support. Where conduit or raceways are required, control circuit wiring must not run in the same conduit/raceway as power wiring over 50 volts. Run all circuits over 50 volts in conduit, metallic tubing, covered metal raceways, or armored cable.

3.1.16 Copper Tubing

Provide hard-drawn copper tubing in exposed areas and either hard-drawn or annealed copper tubing in concealed areas. Use only tool-made bends. Use only brass or copper solder joint type fittings, except for connections to apparatus. For connections to apparatus use brass compression type fittings.

3.1.17 Plastic Tubing

Install plastic tubing within covered raceways or conduit except when otherwise specified. Do not use plastic tubing for applications where the tubing could be subjected to a temperature exceeding 130 degrees F. For fittings, use brass or acetal resin of the compression or barbed push-on type for instrument service. Except in walls and exposed locations, plastic multitube instrument tubing bundle without conduit or raceway protection may be used where a number of air lines run to the same points, provided the multitube bundle is enclosed in a protective sheath, is run parallel to the building lines and is adequately supported as specified.

-- End of Section --

SECTION 23 09 23.01

LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS
02/19

PART 1 GENERAL

1.1 SUMMARY

Provide a complete Direct Digital Control (DDC) system, except for the Front End which is specified in Section 25 10 10 UTILITY MONITORING AND CONTROL (UMCS) FRONT END AND INTEGRATION, suitable for the control of the heating, ventilating and air conditioning (HVAC) and other building-level systems as specified and shown and in accordance with Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

1.1.1 System Requirements

Provide a system meeting the requirements of both Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC and this Section and with the following characteristics:

a. The control system must be an open implementation of LonWorks technology using CEA-709.1-D and Fox as the communications protocols. Except for communication between Niagara Framework components (between Niagara Framework Supervisory Gateways or between a Niagara Framework Supervisory Gateway and a Niagara Framework Front End) which must use the Fox Protocol, the system must use LonMark Standard Network Variable Types as defined in LonMark SNVT List exclusively for communication over the network.

b. Use the Niagara Framework for all network management including addressing and binding of network variables. Each Niagara Framework Supervisory Gateway must contain a database for all controllers connected to its non-IP ports.

c. Install and configure control hardware, except as specified for Niagara Framework Supervisory Gateways, to provide all input and output Standard Network Variables (SNVTs) as indicated and as needed to meet the requirements of this specification. Points in Niagara Framework Supervisory Gateways which do not communicate with non-Niagara Framework DDC Hardware may be exposed via Fox instead.

d. All DDC hardware installed under this specification must communicate via CEA-709.1-D, and Niagara Framework Supervisory Gateways must also communicate over the IP network via Fox. Install the control system such that a SNVT output from any node on the network can be bound to any other node in the same domain.

e. Use Niagara Framework hardware and software exclusively for alarming, scheduling, trending, and communication with a front end (UMCS). Use the Fox protocol for all communication between Niagara Framework Supervisory Gateways; use the CEA-709.1-D protocol for all other building communication. Niagara Framework Supervisory Gateway must serve web pages as specified.

f. Use Niagara Framework Version 4.0 or later to match the existing system.

1.1.2 Verification of Specification Requirements

Review all specifications related to the control system installation and advise the Contracting Officer of any discrepancies before performing any work. If Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC or any other Section referenced in this specification is not included in the project specifications advise the Contracting Officer and either obtain the missing Section or obtain Contracting Officer approval before performing any work.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

CONSUMER ELECTRONICS ASSOCIATION (CEA)

CEA-709.1-D	(2014) Control Network Protocol Specification
CEA-709.3	(1999; R 2015) Free-Topology Twisted-Pair Channel Specification

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 802.3	(2018) Ethernet

INTERNET ENGINEERING TASK FORCE (IETF)

IETF RFC 7465	(2015) Prohibiting RC4 Cipher Suites

LONMARK INTERNATIONAL (LonMark)

LonMark Interoperability Guide	(2005) LonMark Application-Layer Interoperability Guide and LonMark Layer 1-6 Interoperability Guide; Version 3.4
LonMark SCPT List	(2014) LonMark SCPT Master List; Version 15
LonMark SNVT List	(2014) LonMark SNVT Master List; Version 15
LonMark XIF Guide	(2001) LonMark External Interface File Reference Guide; Revision 4.402

~~TRIDIUM, INC (TRIDIUM)~~

~~Niagara Framework~~	~~(2012) NiagaraAX User's Guide~~
~~Tridium Open NiCS~~	~~(2005) Understanding the NiagaraAX Compatibility Statement (NiCS)~~

U.S. FEDERAL COMMUNICATIONS COMMISSION (FCC)

FCC Part 15	Radio Frequency Devices (47 CFR 15)

UNDERWRITERS LABORATORIES (UL)

UL 916	(2015) Standard for Energy Management Equipment

1.3 DEFINITIONS

For definitions related to this section, see Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

1.4 SUBMITTALS

Submittals related to this Section are specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

PART 2 PRODUCTS

All products used to meet this specification must meet the specified requirements, but not all products specified here will be required by every project. Provide products which meet the requirements of both Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC and this Section.

2.1 NETWORK HARDWARE

2.1.1 CEA-709.1-D Routers

CEA-709.1-D Routers must meet the requirements of CEA-709.1-D and must provide connection between two or more CEA-709.3 TP/FT-10 channels, or between one or more CEA-709.3 TP/FT-10 channels and a LonMark Interoperability Guide TP/XF-1250 channel.

2.1.2 CEA-709.1-D Repeaters

CEA-709.1-D Repeaters must be CEA-709.1-D Routers configured as repeaters. Physical layer repeaters are prohibited.

2.1.3 CEA-709.1-D Gateways

In addition to the requirements for DDC Hardware, CEA-709.1-D gateways must be a Niagara Framework Supervisory Gateway or must:

a. Allow bi-directional mapping of data between the non-CEA-709.1-D protocol and SNVTs

b. Incorporate a network connection to a TP/FT-10 network in accordance with CEA-709.3 and a separate connection appropriate for the a non-CEA-709.1-D network

Although Gateways must meet DDC Hardware requirements, except for Niagara Framework Supervisory Gateways, they are not DDC Hardware and must not be used when DDC Hardware is required. (Niagara Framework Supervisory Gateways are both Gateways and DDC Hardware.)

2.1.4 Ethernet Switch

Ethernet Switches must autoconfigure between 10,100 and 1000 megabits per second (MBPS).

2.2 CONTROL NETWORK WIRING

a. Provide TP/FT-10 control wiring in accordance with CEA-709.3.

b. Provide TP/XF-1250 control wiring in accordance with the LonMark Interoperability Guide.

c. For the Building Control Network IP Network provide media that is CAT-5e Ethernet media at a minimum and meets all requirements of IEEE 802.3.

2.3 DIRECT DIGITAL CONTROL (DDC) HARDWARE

All DDC Hardware must meet the following general requirements:

a. Except for Niagara Framework Supervisory Gateways, it must incorporate a "service pin" which, when pressed will cause the DDC Hardware to broadcast its 48-bit NodeID and its ProgramID over the network. The service pin must be distinguishable and accessible.

b. It must incorporate a light to indicate the device is receiving power.

c. Except for Niagara Framework Supervisory Gateways, it must incorporate a TP/FT-10 transceiver in accordance with CEA-709.3 and connections for TP/FT-10 control network wiring. Niagara Framework Supervisory Gateways must incorporate an IP connection and at least one other transceiver. These other transceivers must be either a TP/FT-10 transceiver in accordance with CEA-709.3 or a TP/XF-1250 transceiver in accordance with LonMark Interoperability Guide. Niagara Framework Supervisory gateways must have connection of the appropriate type for each transceiver.

d. It must communicate on the network using only the CEA-709.1-D protocol or the Fox protocol.

e. It must be capable of having network communications configured via the Niagara Framework.

f. It must be locally powered; link powered devices are not acceptable.

g. LonMark external interface files (XIF files), as defined in the LonMark XIF Guide, must be submitted for each type of DDC Hardware except Niagara Framework Supervisory Gateways.

h. Application programs and configuration settings must be stored in a manner such that a loss of power does not result in a loss of the application program or configuration settings:

(1) Loss of power must never result in the loss of application programs, regardless of the length of time power is lost.

(2) Loss of power for less than 2,500 hours must not result in the loss of configured settings.

i. It must have all functionality specified and required to support the application (Sequence of Operation or portion thereof) in which it is used, including but not limited to:

(1) It must provide input and output SNVTs or Niagara Framework Points

as specified, as indicated on the Points Schedule, and as otherwise required to support the sequence and application in which it is used. All SNVTs and Niagara Framework Points must have meaningful names identifying the value represented by the SNVT or Niagara Framework Points . Unless a standard network variable type of an appropriate engineering type is not available, all network variables must be of a standard network variable type with engineering units appropriate to the value the variable represents.

(2) All settings and parameters used by the application in which the DDC hardware is used must be configurable via one of the following: standard configuration properties (SCPTs) as defined in the LonMark SCPT List, user-defined configuration properties (UCPTs), network configuration inputs (*nci*s) of a SNVT type as defined in the LonMark SNVT List, network configuration inputs (*nci*s) of a user defined network variable type, or hardware settings on the controller itself. Niagara Framework Supervisory Gateways may instead be configurable via the Niagara Framework.

j. It must meet FCC Part 15 requirements and have UL 916 or equivalent safety listing.

k. In addition to these general requirements and the DDC Hardware Input-Output (I/O) Function requirements, all DDC Hardware must also meet the requirements of a Niagara Framework Supervisory Gateway, a Local Display Panel (LDP), Application Specific Controller (ASC), General Purpose Programmable Controller (GPPC), or an Application Generic Controller (AGC). All pieces of DDC Hardware must have their DDC Hardware Type identified as part of the Manufacturer's Product Data submittal as specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC. Except for Local Display Panels provided as part of another controller, where a single device meets the requirements of multiple types, select a single type for that specific device based on it's use. Where a Local Display Panel is provided as part of another device, indicate both the controller type and local display panel. One model of DDC hardware may be submitted as different DDC Hardware types when used in multiple applications.

l. The user interface on all DDC Hardware with a user interface which allows for modification of a value must be password protected.

m. Clocks in DDC Hardware incorporating a Clock must continue to function for 120 hours upon loss of power to the DDC Hardware.

2.3.1 Hardware Input-Output (I/O) Functions

DDC Hardware incorporating hardware input-output (I/O) functions must meet the following requirements:

2.3.1.1 Analog Inputs

DDC Hardware analog inputs (AIs) must perform analog to digital (A-to-D) conversion with a minimum resolution of 8 bits plus sign or better as needed to meet the accuracy requirements specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC. Signal conditioning including transient rejection must be provided for each analog input. Analog inputs must be capable of being individually calibrated for zero and span. Calibration via software scaling performed as part of point configuration

is acceptable. The AI must incorporate common mode noise rejection of at least 50 dB from 0 to 100 Hz for differential inputs, and normal mode noise rejection of at least 20 dB at 60 Hz from a source impedance of 10,000 ohms.

2.3.1.2 Analog Outputs

DDC Hardware analog outputs (AOs) must perform digital to analog (D-to-A) conversion with a minimum resolution of 8 bits plus sign, and output a signal with a range of 4-20 mAdc or 0-10 Vdc. Analog outputs must be capable of being individually calibrated for zero and span. Calibration via software scaling performed as part of point configuration is acceptable. DDC Hardware with Hand-Off-Auto (H-O-A) switches for analog outputs must provide for overriding the output through the range of 0 percent to 100 percent.

2.3.1.3 Binary Inputs

DDC Hardware binary inputs (BIs) must accept contact closures and must ignore transients of less than 5 milli-second duration. Protection against a transient of 50 Vac must be provided.

2.3.1.4 Binary Outputs

DDC Hardware binary outputs (BOs) must provide relay contact closures or triac outputs for momentary and maintained operation of output devices. DDC Hardware with H-O-A switches for binary outputs must provide for overriding the output open or closed.

2.3.1.4.1 Relay Contact Closures

Closures must have a minimum duration of 0.1 second. Relays must provide at least 180V of isolation. Electromagnetic interference suppression must be provided on all output lines to limit transients to 50 Vac. Minimum contact rating must be 0.5 amperes at 24 Vac.

2.3.1.4.2 Triac Outputs

Triac outputs must provide at least 180 V of isolation. Minimum contact rating must be 0.5 amperes at 24 Vac.

2.3.1.5 Pulse Accumulator

DDC Hardware pulse accumulators must have the same characteristics as the BI. In addition, a buffer must be provided to totalize pulses. The pulse accumulator must accept rates of at least 20 pulses per second. The totalized value must be resettable via a configurable parameter.

2.3.1.6 Integrated H-O-A Switches

Where integrated H-O-A switches are provided on hardware outputs, controller must provide means of monitoring position or status of H-O-A switch. This feedback may be provided via the Niagara Framework or via network variable.

2.3.2 Local Display Panel (LDP)

The Local Display Panels (LDPs) must be DDC Hardware with a display and navigation buttons or a touch screen display, and must provide display and

adjustment of Niagara Framework points or network variables as indicated on the Points Schedule and as specified. LDPs must be provided as stand-alone DDC Hardware or as an integral part of another piece of DDC Hardware. LDPs must come factory installed with all applications necessary for the device to function as an LDP.

The adjustment of values using display and navigation buttons must be password protected.

2.3.3 Application Specific Controller (ASC)

Application Specific Controllers (ASCs) have a fixed factory-installed application program (i.e. ProgramID) with configurable settings and do not have the ability to be programmed for custom applications. ASCs must meet the following requirements in addition to the General DDC Hardware and DDC Hardware Input-Output (I/O) Function requirements:

a. ASCs must be LonMark Certified.

b. Unless otherwise approved, all necessary Configuration Properties and network configuration inputs (*nci*s) for the sequence and application in which the ASC is used must be fully configurable throughthe Niagara Framework. Application Specific Controller configurable via a Niagara Framework Wizard is preferred. Wizards must be submitted for each type (manufacturer and model) of Application Specific Controller which has a Wizard available for configuration. Wizards distributed under a license must be licensed to the project site. (Note: configuration accomplished via hardware settings does not require configuration via Niagara Framework Wizard.){/NIAGARA FRAMEWORK}

c. ASCs may include an integral or tethered Local Display Panel

2.3.4 General Purpose Programmable Controller (GPPC)

A General Purpose Programmable Controller (GPPC) must be programmed for the application. GPPCs must meet the following requirements in addition to the general DDC Hardware requirements and Hardware Input-Output (I/O) Functions:

a. The programmed GPPC must conform to the LonMark Interoperability Guide.

b. All programming software required to program the GPPC must be delivered to and licensed to the project site in accordance with Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC. Submit the most recent version of the Programming software for each type (manufacturer and model) of General Purpose Programmable Controller (GPPC).

c. Submit copies of the installed GPPC application programs (all software that is not common to every controller of the same manufacturer and model) as source code compatible with the supplied programming software in accordance with Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC. The submitted GPPC application program must be the complete application necessary for the GPPC to function as installed and be sufficient to allow replacement of the installed controller with a GPPC of the same type.

d. GPPCs may be include an integral or tethered Local Display Panel

2.3.5 Application Generic Controller (AGC)

An Application Generic Controller (AGC) has a fixed application program which includes the ability to be programmed for custom applications. AGCs must meet the following requirements in addition to the general DDC Hardware requirements and Hardware Input-Output (I/O) Functions:

a. The programmed AGC must conform to the LonMark Interoperability Guide.

b. The AGC must have a fixed ProgramID and fixed XIF file.

c. Unless otherwise approved, the ACG must be fully configurable and programmable for the application using one or more Niagara Framework Wizards, all of which must be submitted as specified for each type of AGC (manufacturer and model).

d. Submit copies of the installed AGC application programs as source code compatible with the supplied Niagara Framework Wizard used for programming the device in accordance with Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC. The submitted AGC application program must be the complete application program necessary for the AGC to function as installed and be sufficient to allow replacement of the installed controller with an AGC of the same type.

e. AGCs may be include an integral or tethered Local Display Panel

2.3.6 Niagara Framework Supervisory Gateway

Any device implementing the Niagara Framework is a Niagara Framework Supervisory Gateway and must meet these requirements. In addition to the general requirements for all DDC Hardware, Niagara Framework Supervisory Gateway Hardware must:

a. Be direct digital control hardware.

b. Have an unrestricted interoperability license and its Niagara Comparability Statement (NiCS) must follow the Tridium Open NiCS Specification.

c. Manage communications between a field control network and the Niagara Framework Monitoring and Control Software, and between itself and other Niagara Framework Supervisory Gateways. Niagara Framework Supervisory Gateway Hardware must use Fox protocol for communication with other Niagara Framework Components, regardless of the manufacturer of the other components.

d. Be fully programmable using the Niagara Framework Engineering Tool and must support the following:

(1) Time synchronization, Calendar, and Scheduling using Niagara Scheduling Objects

(2) Alarm generation and routing using the Niagara Alarm Service

(3) Trending using the Niagara History Service and Niagara Trend Log Objects

(4) Integration of field control networks using the Niagara Framework Engineering Tool

(5) Configuration of integrated field control system using the Niagara Framework Engineering Tool when supported by the field control system

e. Meet the following minimum hardware requirements:

(1) One 10/100 Mbps Ethernet Port

f. provide access to field control network data and supervisory functions via web interface and support a minimum of 16 simultaneous users. Note: implementation of this capability may not be required on this project; see requirements in PART 3, EXECUTION of this Section.

g. Submit a backup of each Niagara Framework Supervisory Gateway as specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC. The backup must be sufficient to restore a Niagara Framework Supervisory Gateway to the final as-built condition such that a new Niagara Framework Supervisory Gateway loaded with the backup is indistinguishable in functionality from the original.

2.4 Niagara Framework Engineering Tool

The Niagara Framework Engineering Tool must be Niagara Workbench or an equivalent Niagara Framework engineering tool software and must:

a. have an unrestricted interoperability license and its Niagara Compatibility Statement (NiCS) must follow the Tridium Open NiCS Specification.

b. be capable of performing network configuration for Niagara Framework Supervisory Gateways and Niagara Framework Monitoring and Control Software.

c. be capable of programming and configuring of Niagara Framework Supervisory Gateways and Niagara Framework Monitoring and Control Software.

d. be capable of discovery of Niagara Framework Supervisory Gateways and all points mapped into each Niagara Framework Supervisory Gateway and making these points accessible to Niagara Framework Monitoring and Control Software.

Monitoring and Control Software is specified in Section 25 10 10 UTILITY MONITORING AND CONTROL SYSTEM (UMCS) FRONT END AND INTEGRATION.

PART 3 EXECUTION

3.1 CONTROL SYSTEM INSTALLATION

3.1.1 Niagara Framework Engineering Tool

The project site currently has the Niagara Framework Engineering Tool. If this software is not adequate for programming the Niagara Framework Supervisory Gateways provided under this project, provide a Niagara Framework Engineering Tool as specified.

3.1.2 Building Control Network (BCN)

Provide a Building Control Network (BCN) connecting all DDC hardware as specified. The Building Control Network (BCN) must consist of an IP Network, one or more Niagara Framework Supervisory Gateways, and one or more Non-IP Building Control Network Channels:

3.1.2.1 Building Control Network (BCN) Installation

Provide building control networks meeting the following requirements:

a. Provide a Building Control Network IP Network, Non-IP Building Control Network Channels and Niagara Framework Supervisory Gateways to a create a single building control network connecting all DDC Hardware.

b. In addition to the connection to the Niagara Framework Supervisory Gateway, each Non-IP Building Control Network (BCN) Channel directly connected to a Niagara Framework Supervisory Gateway must be directly connected to either DDC Hardware or to CEA-709.1-D Routers, but not to both. A channel containing only CEA-709.1-D Routers is a backbone channel and a channel containing DDC Hardware is a non-backbone channel.

c. When only a single Niagara Framework Supervisory Gateway is required, the IP network consists of only the Niagara Framework Supervisory Gateway. When multiple Niagara Framework Supervisory Gateways are required, provide an IP Network connecting all Niagara Framework Supervisory Gateways.

d. Connect all DDC Hardware other than Niagara Framework Supervisory Gateways to a non-backbone BCN Channel. Connect all Niagara Framework Supervisory Gateways to the Building Control Network (BCN) IP Network.

e. Install components such that there is no more than than one CEA-709.1-D Router between any DDC Hardware and a Niagara Framework Supervisory Gateway

f. Install the network such that the peak expected bandwidth usage for each and every channel is less than 70 percent, including device-to-device traffic and traffic to the Utility Monitoring and Control System (UMCS) as indicated on the Points Schedule.

g. Where multiple pieces of DDC Hardware are used in the execution of a single sequence of operation, directly connect all DDC Hardware used to execute the sequence to the same channel and do not install other DDC Hardware, other than a Niagara Framework Supervisory Gateway, to that channel.

3.1.2.2 Non-IP Building Control Network (BCN) Channel

Provide Non-IP Building Control Network (BCN) Channels meeting the following requirements:

a. For each non-backbone channel, provide a TP/FT-10 channel in doubly terminated bus topology in accordance with CEA-709.3. For each backbone channel, provide either a TP/FT-10 channel in doubly terminated bus topology in accordance with CEA-709.3 or a TP/XF-1250 channel in accordance with the LonMark Interoperability Guide.

b. Connect no more than 2/3 the maximum number of devices permitted by CEA-709.3 to each TP/FT-10 channel. Connect no more than 2/3 the maximum number of devices permitted by LonMark Interoperability Guide to TP/XF-1250 channel.

c. Connect no more than 2/3 the maximum number of devices permitted by the manufacturer of the device transceivers to each channel. When more than one type of transceiver is used on the same channel, use the transceiver with the lowest maximum number of devices to calculate the 2/3 limit.

3.1.2.3 Building Control Network (BCN) IP Network

Install IP Network Cabling in conduit. Install Ethernet Switches in lockable enclosures. Install the Building Control Network (BCN) IP Network so that it is available at the Facility Point of Connection (FPOC) location as specified. When the FPOC location is a room number, provide sufficient additional media to ensure that the Building Control Network (BCN) IP Network can be extended to any location in the room.

3.1.3 DDC Hardware

Install Niagara Framework Supervisory Gateways in lockable enclosures. Install other DDC Hardware which is not is suspended ceilings in enclosures.

Configure and commission all DDC Hardware on the Building Control Network via the Niagara Framework. Use Application Specific Controllers whenever an Application Specific Controller suitable for the application exists. When an Application Specific Controller suitable for the application does not exist use a Niagara Framework Supervisory Gateway or Application Generic Controllers, General Purpose Programmable Controllers or multiple Application Specific Controllers.

3.1.3.1 Hand-Off-Auto (H-O-A) Switches

Provide Hand-Off-Auto (H-O-A) switches for all DDC Hardware analog outputs and binary outputs used for control of systems other than terminal units, as specified and as indicated on the Points Schedule. H-O-A switches must be integral to the controller hardware, an external device co-located with (in the same enclosure as) the controller, integral to the controlled equipment, or an external device co-located with (in the same enclosure as) the controlled equipment.

a. For H-O-A switches integral to DDC Hardware, meet the requirements specified in paragraph DIRECT DIGITAL CONTROL (DDC) HARDWARE.

b. For external H-O-A switches for binary outputs, provide switches capable of overriding the output open or closed.

c. For external H-O-A switches for analog outputs, provide switches capable of overriding through the range of 0 percent to 100 percent.

3.1.3.2 Local Display Panels

Provide LDPs to display and override values of points in a Niagara Framework Supervisory Gateway or Network Variables as indicated on the Points Schedule. Install LDPs displaying points for anything other than a terminal unit in the same room as the equipment. Install LDPs displaying

points for only terminal units in a mechanical room central to the group of terminal units it serves.

3.1.3.3 Graphics and Web Pages

Configure Niagara Framework Supervisory Gateways to use web pages to provide a graphical user interface including System Displays using the project site sample displays, including overrides, as indicated on the Points Schedule and as specified. Label all points on displays with the point name as indicated on the Points Schedule. Configure user permissions for access to and executions of action using graphic pages. Coordinate user permissions with the Controls shop supervisor. Configure the web server to use HTTPS based on the Transport Layer Security (TLS) protocol in accordance with IETF RFC 7465 using a Government furnished certificate.

3.1.3.4 Overrides for GPPCs and AGCs

Provide the capability to override points for all General Purpose Programmable Controllers and Application Generic Controllers as specified and as indicated on the Points Schedule using one of the following methods:

a. Override SNVT of Same SNVT Type method:

(1) Use this method for all setpoint overrides and for overrides of inputs and outputs whenever practical.

(2) Provide a SNVT input to the DDC hardware containing the point to be overridden of the same SNVT type as the point to be overridden.

(3) Program and configure the DDC hardware such that:

(a) If the value of the SNVT on the override input is the *Invalid Value* defined for that SNVT by the LonMark SNVT List, then the point is not overridden (its value is determined from the sequence).

(b) If the value of the SNVT on the override input is not the *Invalid Value* defined for that SNVT by the LonMark SNVT List then set the value of the point to be overridden to the value of the SNVT on the override input.

b. HVAC Override SNVT method:

(1) Use this method for override of inputs and outputs when the "Override SNVT Shares SNVT Type" method is impractical.

(2) Provide a SNVT input to the DDC hardware containing the point to be overridden of SNVT type *SNVT_hvac_overid*. Show on the Points Schedule how to perform the specified override using this SNVT.

3.1.3.5 Overrides for ASCs

Whenever possible use the methods specified for General Purpose Programmable Controllers and Application Generic Controllers to perform overrides for all Application Specific Controllers. If neither the "Override SNVT of Same SNVT Type" method or "HVAC Override SNVT" method are supported by the Application Specific Controller show this on the Points Schedule and perform overrides as follows:

a. Provide one or more SNVT input(s) to the DDC hardware containing the point to be overridden. Document the number and type of each SNVT provided on the Points Schedule.

b. Configure the Application Specific Controller such that:

(1) For some specific combination or combinations of values at the SNVT override input(s) the point is not overridden, and its value is determined from the sequence as usual. Show on the Points Schedule the values required at the SNVT override input(s) to not override the point.

(2) For other specific combinations of SNVT override input(s), the value of the point to be overridden is determined from the value of the override input(s). Show on the Points Schedule the correlation between the SNVT override input(s) and the resulting value of the overridden point.

3.1.4 Scheduling, Alarming, Trending and Overrides

3.1.4.1 Scheduling

Configure schedules in Niagara Framework Supervisory Gateway using Niagara Schedule Objects as indicated on the Points Schedule and as specified. When the schedule is controlling occupancy modes in DDC Hardware other than a Niagara Framework Supervisory Gateway use a network variable of type SNVT_Occupancy.

3.1.4.1.1 Schedule Groupings

Provide a separate schedule for each AHU including it's associated Terminal Units and for each stand-alone Terminal Unit (those not dependent upon AHU service) or group of stand-alone Terminal Units acting according to a common schedule.

3.1.4.1.2 Occupancy Mode Mapping to SNVT Values

Use the following mapping between SNVT_Occupancy enumerations and occupancy modes:

a. OCCUPIED mode: Enumeration value of OC_OCCUPIED
b. UNOCCUPIED mode: Enumeration value of OC_UNOCCUPIED
c. WARM-UP/COOL-DOWN (PRE-OCCUPANCY) mode: Enumeration value of OC_STANDBY

3.1.4.2 Alarming

For each point not in a Niagara Framework Supervisory Gateway which is shown on the Points Schedule with an alarm condition, provide a SNVT output for the point to be used for alarm generation. For each point which is shown on the Points Schedule with an alarm condition, configure alarms in Niagara Framework Supervisory Gateway using Niagara Alarm Extensions and Alarm Services.

3.1.4.3 Trending

For each point not in a Niagara Framework Supervisory Gateway which is shown on the Points Schedule as requiring a trend, provide a SNVT output for the point to be used for trending. For each point which is shown on the Points Schedule as requiring a trend, configure a trend in a Niagara

Framework Supervisory Gateway using Niagara Framework History Extensions and the Niagara Framework History Service.

3.1.4.4 Overrides

Provide overrides for points as indicated on the Points Schedule. For overrides to points in Niagara Framework Supervisory Gateways, use the Niagara Framework. For overrides to other points, provide an override to a point in a Niagara Framework Supervisory Gateway via the Niagara Framework where the Niagara Framework Supervisory Gateway overrides the other point as specified in paragraphs "Overrides for GPPCs and AGCs" and "Overrides for ASCs"

3.1.5 Gateways

The requirements in this paragraph do not permit the installation of hardware not meeting the other requirements of this section. All control hardware installed under this project must meet the requirements of this specification, including control hardware provided as part of a package unit or as part of HVAC equipment specified under another section. Except as indicated in paragraph Gateways for Boiler or Chiller Plants, all package units must be provided with a CEA-709.1-D interface meeting the requirements of this Section. Only use gateways to connect to pre-existing control devices, and to boiler or chiller plants as indicated..

3.1.5.1 General Gateway Requirements

Provide Gateways to connect non-CEA-709.1-D control hardware in accordance with the following:

a. Configure gateway to map writeable data points in the controlled equipment to Network Variable Inputs of Standard Network Variable Types as defined by the LonMark SNVT List, or to Niagara Framework points, as indicated in the Points Schedule and as specified.

b. Configure gateway to map readable data points in the controlled equipment to Network Variable Outputs of Standard Network Variable Types as defined by the LonMark SNVT List, or to Niagara Framework points, as indicated in the Points Schedule and as specified.

c. Do not use non-CEA-709.1-D control hardware for controlling built-up units or any other equipment that was not furnished with factory-installed controls. (Note: A Niagara Framework Supervisory Gateway is CEA-709.1-D control hardware.)

d. Do not use non-CEA-709.1-D control hardware for system scheduling functions.

3.1.5.2 Gateways for Boiler or Chiller Plants

A non-CEA-709.1-D network of multiple boilers or multiple chillers with a single gateway is permitted only when all the following conditions are met:

a. All units are from the same manufacturer.

b. All units are co-located in the same room, and the network connecting

them is fully contained in that room.

c. Units are operating using a common "plant" sequence of operation which stages the units in a manner that requires operational parameters be shared between them and which cannot be accomplished with a single lead-lag command from a third-party controller.

d. A request for use of a boiler or chiller plant gateway has been submitted and approved in accordance with Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

Connect one network port on the gateway to the Building Control Backbone Network the other port to the boiler or chiller network.

3.1.5.3 Gateways for Application Other than Boiler and Chiller Plants

In addition to the General Gateway Requirements, provide BACnet Gateways to non-BACnet control hardware other than boiler and chiller plants in accordance with the following

a. Each gateway must communicate with and perform protocol translation for non-CEA-709.1-D control hardware controlling one and only one package unit.

b. Connect one network port on the gateway to the Building Control Network and the other port to the single piece of controlled equipment.

h. con-CEA-709.1-D network wiring connecting the gateway to the package unit must not exceed 10 feet in length and must connect to exactly two devices: the controlled equipment (packaged unit) and the gateway.

3.1.6 Network Interface Jack

Provide standard network interface jacks such that each node on the control network is within 10 ft of an interface jack. For terminal unit controllers with hardwired thermostats this network interface jack may instead be located at the thermostat. Locating the interface jack at the thermostat is preferred. If the network interface jack is other than a 1/8 inch phone jack, provide an interface cable with a standard 1/8 inch phone jack on one end and a connector suitable for mating with installed network interface jack on the other. No more than one type of interface cable must be required to access all network interface jacks. Furnish one interface cable.

-- End of Section --

SECTION 23 11 20

FACILITY AND EXTERIOR SITE GAS PIPING
05/20

PART 1 GENERAL

1.1 SUMMARY

This specification section applies to exterior site gas piping, gas piping installed within buildings incidental underground piping under building, above ground steel piping and corrugated stainless steel tubing (CSST) both outside (up to 5 feet beyond exterior walls) and within buildings in compliance with NFPA 54/AGA Z223.1, "National Fuel Gas Code" NFPA 58, "Fuel Gas Piping".

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN GAS ASSOCIATION (AGA)

AGA ANSI B109.1	(2000) Diaphragm Type Gas Displacement Meters (Under 500 cubic ft./hour Capacity)
AGA ANSI B109.2	(2000) Diaphragm Type Gas Displacement Meters (500 cubic ft./hour Capacity and Over)
AGA ANSI B109.3	(2019) Rotary-Type Gas Displacement Meters
AGA ANSI B109.4	(2016) Self-Operated Diaphragm-Type Natural Gas Service Regulators for Nominal Pipe Size 1¼ inches (32 mm) and Smaller with Outlet Pressures of 2 psig (13.8 kPa) and Less
AGA XR0603	(2006; 8th Ed) AGA Plastic Pipe Manual for Gas Service
AGA Z223.1	(2012) National Fuel Gas Code

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z21.1/CSA 1.1	(2018) Household Cooking Gas Appliances
ANSI Z21.15/CSA 9.1	(2009; Addenda A 2012, Addenda B 2013; R 2019) Manually Operated Gas Valves for Appliances, Appliance Connector Valves and Hose End Valves
ANSI Z21.18/CSA 6.3	(2007; R 2017) Gas Appliance Pressure Regulators
ANSI Z21.21/CSA 6.5	(2015) Automatic Valves for Gas Appliances

ANSI Z21.24/CSA 6.10	(2015; R 2020) Connectors for Gas Appliances
ANSI Z21.41/CSA 6.9	(2014; R 2019) Quick-Disconnect Devices for Use with Gas Fuel Appliances
ANSI Z21.69/CSA 6.16	(2015; R 2020) Connectors for Movable Gas Appliances
ANSI Z21.78/CSA 6.20	(2010; R 2020) Standard Specification for Combination Gas Controls for Gas Appliances
ANSI Z21.80/CSA 6.22	(2019) Line Pressure Regulators
ANSI Z21.93/CSA 6.30	(2017) Excess Flow Valves for Natural Gas and Propane Gas with Pressures up to 5 psig

AMERICAN PETROLEUM INSTITUTE (API)

API 570	(2016; Addendum 1 2017; Addendum 2 2018; ERTA 1 2018) Piping Inspection Code: In-Service Inspection, Rating, Repair, and Alteration of Piping Systems
API RP 2003	(2015; 8th Ed) Protection Against Ignitions Arising out of Static, Lightning, and Stray Currents
API RP 2009	(2002; R 2007; 7th Ed) Safe Welding, Cutting, and Hot Work Practices in Refineries, Gasoline Plants, and Petrochemical Plants
API Spec 5CT	(2018) Casing and Tubing
API Spec 6D	(June 2018, 4th Ed; Errata 1 July 2018; Errata 2 August 2018) Specification for Pipeline and Piping Valves
API Std 598	(2009) Valve Inspecting and Testing
API Std 607	(2016) Fire Test for Quarter-turn Valves and Valves Equipped with Non-metallic Seats

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME A13.1	(2015) Scheme for the Identification of Piping Systems
ASME B1.1	(2003; R 2018) Unified Inch Screw Threads (UN and UNR Thread Form)
ASME B1.20.1	(2013; R 2018) Pipe Threads, General Purpose (Inch)
ASME B16.1	(2015) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250

ASME B16.3	(2016) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.5	(2017) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.9	(2018) Factory-Made Wrought Buttwelding Fittings
ASME B16.11	(2016) Forged Fittings, Socket-Welding and Threaded
ASME B16.21	(2016) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.33	(2012; R 2017) Manually Operated Metallic Gas Valves for Use in Gas Piping Systems Up to 125 psi, (Sizes NPS 1/2 - NPS 2)
ASME B16.39	(2020) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300
ASME B18.2.1	(2012; Errata 2013) Square and Hex Bolts and Screws (Inch Series)
ASME B18.2.2	(2015) Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)
ASME B31.8	(2018; Supplement 2018) Gas Transmission and Distribution Piping Systems
ASME B31.9	(2017) Building Services Piping
ASME B36.10M	(2015; Errata 2016) Welded and Seamless Wrought Steel Pipe
ASME BPVC SEC IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C203	(2008) Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot-Applied
AWWA C213	(2015) Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines

AMERICAN WELDING SOCIETY (AWS)

AWS A5.8/A5.8M	(2019) Specification for Filler Metals for Brazing and Braze Welding

AWS WHB-2.9	(2004) Welding Handbook; Volume 2, Welding Processes, Part 1

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2020) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A105/A105M	(2018) Standard Specification for Carbon Steel Forgings for Piping Applications
ASTM A193/A193M	(2020) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A194/A194M	(2020a) Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
ASTM B88	(2020) Standard Specification for Seamless Copper Water Tube
ASTM B280	(2020) Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service
ASTM D2513	(2018a) Standard Specification for Polyethylene (PE) Gas Pressure Pipe, Tubing, and Fittings
ASTM D3308	(2012; R 2017) Standard Specification for PTFE Resin Skived Tape
ASTM F2015	(2000; R 2013) Standard Specification for Lap Joint Flange Pipe End Applications

CSA GROUP (CSA)

ANSI LC 1/CSA 6.26	(2019) Fuel Gas Piping Systems Using Corrugated Stainless Steel Tubing (CSST)
CGA 9.2-M88	(1988; R 2009) Manually Operated Shut-Off Valves for Gas Piping Systems

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-25	(2018) Standard Marking System for Valves, Fittings, Flanges and Unions
MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-110	(2010) Ball Valves Threaded,

	Socket-Welding, Solder Joint, Grooved and Flared Ends

NACE INTERNATIONAL (NACE)

NACE SP0274	(1974; R 2011) High Voltage Electrical Inspection of Pipeline Coatings

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 54	(2018) National Fuel Gas Code
NFPA 58	(2020) Liquefied Petroleum Gas Code
NFPA 70	(2020; ERTA 20-1 2020; ERTA 20-2 2020; TIA 20-1; TIA 20-2; TIA 20-3; TIA 20-4) National Electrical Code

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 6/NACE No.3	(2007) Commercial Blast Cleaning

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-STD-101	(2014; Rev C) Color Code for Pipelines and for Compressed Gas Cylinders
UFC 3-570-01	(2019) Cathodic Protection, With Change 1

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

49 CFR 192	Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards

UNDERWRITERS LABORATORIES (UL)

UL FLAMMABLE & COMBUSTIBLE	(2012) Flammable and Combustible Liquids and Gases Equipment Directory

1.3 SYSTEM DESCRIPTION

The gas piping system includes natural gas piping and appurtenances from point of connection with supply system, as indicated, to gas operated equipment within the facility. Submit operation and maintenance data in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA, in three separate packages. ~~Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS applies to this section, with additions and modifications specified herein.~~ Provide cathodically protected insulating joints connecting aboveground piping from the meter to the building, with lightning arrestors conforming to API RP 2003, installed where indicated.

1.3.1 Gas Facility System and Equipment Operation

Include shop drawings showing piping layout, locations of system valves, gas line markersand cathodic protection system; step-by-step procedures for system start up, operation and shutdown (index system components and equipment to the system drawings); isolation procedures including valve operation to shutdown or isolate each section of the system (index valves to the system maps and provide separate procedures for normal operation

and emergency shutdown if required to be different). Submit Data package No. 4.

1.3.2 Gas Facility System Maintenance

Include maintenance procedures and frequency for system and equipment; identification of pipe materials and manufacturer by locations, pipe repair procedures, and jointing procedures at transitions to other piping material or material from a different manufacturer. Submit Data Package No.4.

1.3.3 Gas Facility Equipment Maintenance

Include identification of valves, shut-offs, disconnects, and other equipment by materials, manufacturer, vendor identification and location; maintenance procedures and recommended tool kits for valves and equipment; recommended repair methods (i.e., field repair, factory repair, or replacement) for each valve and piece of equipment; and preventive maintenance procedures, possible failure modes and troubleshooting guide. Submit Data Package No. 3.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval.information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Gas Piping System; G, RO

SD-03 Product Data

Pipe and Fittings; G, RO

Gas Equipment Connectors; G, RO

Gas Piping System; G, RO

Pipe Coating Materials; G, RO

Pressure Regulators; G, RO

Risers; G, RO

Transition Fittings; G, RO

Valves; G, RO

Warning and Identification Tape; G, RO

SD-06 Test Reports

Testing; G, RO

Pressure Tests; G, RO

Test with Gas; G, RO

SD-07 Certificates

Welders Procedures and Qualifications; G, RO

Assigned Number, Letter, or Symbol; G, RO

SD-08 Manufacturer's Instructions

PE Pipe and Fittings; G, RO

Pipe Coating Materials; G, RO

SD-10 Operation and Maintenance Data

Gas Facility System and Equipment Operation; G, RO

Gas Facility System Maintenance; G, RO

Gas Facility Equipment Maintenance; G, RO

1.5 QUALITY ASSURANCE

Submit manufacturer's descriptive data and installation instructions for approval for compression-type mechanical joints used in joining dissimilar materials and for insulating joints. Mark all valves, flanges and fittings in accordance with MSS SP-25.

1.5.1 Welding Qualifications

a. Weld piping in accordance with qualified procedures using performance qualified welders and welding operators in accordance with API RP 2009, ASME BPVC SEC IX, and ASME B31.9. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.9. Notify the Contracting Officer at least 24 hours in advance of tests, and perform at the work site if practicable.

b. Submit a certified copy of welders procedures and qualifications metal and PE in conformance with ASME B31.9 for each welder and welding operator. Submit the assigned number, letter, or symbol that will be used in identifying the work of each welder to the Contracting Officer. Weld all structural members in accordance ~~with Section 05 05 23.16 STRUCTURAL WELDING, and in conformance~~ with AWS A5.8/A5.8M, and AWS WHB-2.9.

1.5.2 Jointing Thermoplastic and Fiberglass Piping

Perform all jointing of piping using qualified joiners and qualified procedures in accordance with AGA XR0603. Furnish the Contracting Officer with a copy of qualified procedures and list of and identification symbols of qualified joiners. Submit manufacturer's installation instructions and manufacturer's visual joint appearance chart, including all PE pipe and fittings.

1.5.3 Shop Drawings

Submit drawings for complete exterior site and interior Gas Piping System, within 30 days of contract award, showing location, size and all branches of pipeline; location of all required shutoff valves; and instructions necessary for the installation of gas equipment connectors and supports.

1.5.4 Connecting and Abatement Plan

Submit written notification of the method and schedule for making connections to existing gas lines, to the Contracting Officer at least 10 days in advance. Include gas line tie in, hot taps, abandonment/removal or demolition, purging, and plugging as applicable in conformance with ASME B31.8. Include in submittal connections to existing lines.

1.6 DELIVERY, STORAGE, AND HANDLING

1.6.1 Plastic Pipe

Handle, transport, and store plastic pipe and fittings carefully. Plug or cap pipe and fittings ends during transportation or storage to minimize dirt and moisture entry. Do not subject piping to abrasion or concentrated external loads. Discard PE pipe sections and fittings that have been damaged.

1.6.2 Delivery and Storage

Inspect materials delivered to the site for damage, and store with a minimum of handling. Store materials on site in enclosures or under protective coverings. Do not store materials directly on the ground. Keep inside of pipes and fittings free of dirt and debris.

1.6.3 Handling

Handle pipe and components carefully to ensure a sound, undamaged condition. Take particular care not to damage pipe coating. Repair damaged coatings to original finish. Do not place pipe or material of any kind inside another pipe or fitting after the coating has been applied, except as specified in paragraph INSTALLATION. Handle steel piping with coal-tar enamel coating in accordance with AWWA C203, and fusion-bonded epoxy coatings per AWWA C213.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

All products and materials shall be in accordance with Central Hudson Gas and Electric Corporation and West Point Engineering Planning Standards. Provide materials and equipment which are the standard products of a manufacturer regularly engaged in the manufacture of the products and that essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Asbestos or products containing asbestos are not allowed. Submit catalog data and installation instructions for pipe, valves, all related system components, pipe coating materials and application procedures. Conform to NFPA 54NFPA 58 and with requirements specified herein. Provide supply piping to appliances or equipment at least as large as the inlets thereof.

2.2 GAS PIPING SYSTEM AND FITTINGS

2.2.1 Steel Pipe, Joints, and Fittings

Gas piping shall be standard weight, Schedule 40, Black Steel Pipe. Steel pipe and fittings installed below grade or in contact with the soil must be protected from corrosion by a suitable coating and cathodic protection system. Paint pipe and fittings installed aboveground. Verify that pipe wall thickness conforms to ASME B31.8 for larger sizes and high pressures.

a. Pipe: Black carbon steel in accordance with ASTM A53/A53M, Schedule 40, threaded ends for sizes 2 inches and smaller; otherwise, plain end beveled for butt welding.

b. Threaded Fittings: ASME B16.3, black malleable iron.

c. Socket-Welding Fittings: ASME B16.11, forged steel.

d. Butt-Welding Fittings: ASME B16.9, with backing rings of compatible material.

e. Unions: ASME B16.39, black malleable iron.

f. Flanges and Flanged Fittings: ASME B16.5, Class 150, steel flanges or convoluted steel flanges conforming to ASME BPVC SEC VIII D1, with flange faces having integral grooves of rectangular cross sections which afford containment for self-energizing gasket material. Provide buttweld fittings in accordance with ASME B16.9. Use weld neck flanges.

Provide steel pipe conforming to ASME B36.10M; and malleable-iron threaded fittings conforming to ASME B16.1 and ASME B16.3. Provide steel pipe flanges and flanged fittings, including bolts, nuts, and bolt pattern in accordance with ASME B16.5 and ASTM A105/A105M. Provide wrought steel buttwelding fittings conforming to ASME B16.9. Provide socket welding and threaded forged steel fittings conforming to ASME B16.11.

2.2.2 Copper Tubing, Joints and Fittings

Provide copper tubing conforming to ASTM B88, Type K or L, or ASTM B280, with tubing joints made up with tubing fittings recommended by the tubing manufacturer. Provide copper and copper alloy press fittings, with sealing elements of Hydrogenated Nitrile Butadiene Rubber (HNBR), factory installed, or an alternative supplied by the fitting manufacturer.

2.2.3 Thermoplastic Pipe, Tubing, Joints, and Fittings

Provide thermoplastic pipe, tubing,casing and joints and fittings conforming to ASTM D2513 and API Spec 5CT.

2.2.4 Corrugated Stainless Steel Tubing, Fittings and Accessories

Provide corrugated stainless steel tubing conforming to ANSI LC 1/CSA 6.26 (austenitic stainless steel of series 300) with tubing joints made with special mechanical fittings as supplied by the tubing manufacturer.

2.2.4.1 Tubing

Austenitic stainless alloy of series 300 with polyethylene jacket/coating in accordance with ANSI LC 1/CSA 6.26 for sizes 3/8-inch through 2-inch

2.2.4.2 Mechanical Fittings

Copper alloy with one end matched to the corrugated tubing and one end with NPT threads in accordance with ASME B1.20.1

2.2.4.3 Striker Plates

Hardened steel designed to protect tubing from mechanical damage in accordance with ANSI LC 1/CSA 6.26

2.2.4.4 Manifolds

Malleable iron, steel or copper alloy with threaded connections/ports in accordance with ASME B1.20.1

2.2.5 Sealants for Steel Pipe Threaded Joints

Provide joint sealing compound as listed in UL FLAMMABLE & COMBUSTIBLE, Class 20 or less. Provide polyetrafluoroethylene tape conforming to ASTM D3308..

2.2.6 Warning and Identification

Provide pipe flow markings, warning and identification tape, and metal tags as required.

2.2.7 Flange Gaskets

Provide gaskets of nonasbestos compressed material in accordance with ASME B16.21, 1/16 inch thickness, full face or self-centering flat ring type, containing aramid fibers bonded with styrene butadiene rubber (SBR) or nitrile butadiene rubber (NBR) suitable for a maximum 600 degree F service, to be used for hydrocarbon service.

2.2.8 Pipe Threads

Provide pipe threads conforming to ASME B1.20.1.

2.2.9 Escutcheons

Provide chromium-plated steel or chromium-plated brass escutcheons, either one piece or split pattern, held in place by internal spring tension or set screw.

2.2.10 Gas Transition Fittings

a. Provide steel to plastic (PE) designed for steel-to-plastic with tapping tee or sleeve conforming to AGA XR0603 requirements for transitions fittings. Coat or wrap exposed steel pipe with heavy plastic coating.

b. Plastic to Plastic: Manufacturer's standard fused tapping (PE-to-PE) tee assembly with shut-off feature.

c. Provide manually operated shut-off valve conforming to CGA 9.2-M88.

2.2.11 Insulating Pipe Joints

2.2.11.1 Insulating Joint Material

Provide insulating joint material between flanged or threaded metallic pipe systems where shown to control galvanic or electrical action.

2.2.11.2 Threaded Pipe Joints

Provide threaded pipe joints of steel body nut type dielectric unions with insulating gaskets.

2.2.11.3 Flanged Pipe Joints

Provide joints for flanged pipe consisting of full face sandwich-type flange insulating gasket of the dielectric type, insulating sleeves for flange bolts, and insulating washers for flange nuts. Provide lap joint flange pipe ends conforming to ASTM F2015.

2.2.12 Flexible Connectors

a. Provide flexible connectors for connecting gas utilization equipment to building gas piping conforming to ANSI Z21.24/CSA 6.10 or ANSI Z21.41/CSA 6.9 for quick disconnect devices, and flexible connectors for movable food service equipment conforming to ANSI Z21.69/CSA 6.16. Provide combination gas controls for gas appliances conforming to ANSI Z21.78/CSA 6.20.

b. Do not install the flexible connector through the appliance cabinet face. Provide rigid metallic pipe and fittings to extend the final connection beyond the cabinet, except when appliance is provided with an external connection point.

2.3 VALVES

Provide lockable shutoff or service isolation valves as indicated in the drawings conforming to the following:

2.3.1 Valves 2 Inches and Smaller

Provide valves 2 inches and smaller conforming to ASME B16.33 of materials and manufacture compatible with system materials used. Provide manually operated household cooking gas appliance valves conforming to ANSI Z21.1/CSA 1.1 and ANSI Z21.15/CSA 9.1.

2.3.2 Valves 2-1/2 Inches and Larger

Provide valves 2-1/2 inches and larger of carbon steel conforming to API Spec 6D, Class 150.

2.3.3 Valve Support on PE Piping

Provide valve support assembly in accordance with the PE piping maufacturer's requirements at valve terminations points.

2.3.4 Site Underground Valves

Provide valves suitable for shutoff or isolation service and conforming to MSS SP-110 and the following:

2.3.4.1 Steel Valves

Provide steel valves 2 inches and larger installed underground conforming to API Spec 6D, carbon steel, buttweld ends, Class 150 with square wrench operator adaptor. Provide steel valves 2 inches and larger installed aboveground conforming to API Spec 6D, carbon steel, buttweld or flanged ends, Class 150 with handwheel or wrench operator.

2.4 RISERS

Provide manufacturer's standard riser, transition from plastic to steel pipe with 7 to 12 mil thick epoxy coating. Use swaged gas-tight construction with O-ring seals, metal insert, and protective sleeve. Provide remote bolt-on or bracket or wall-mounted riser supports as indicated.

2.5 PIPE HANGERS AND SUPPORTS

Provide pipe hangers and supports conforming to MSS SP-58.

2.6 LINE AND APPLIANCE REGULATORS AND SHUTOFF VALVES

Provide regulators conforming to ANSI Z21.18/CSA 6.3 for appliances, ANSI Z21.78/CSA 6.20 for combination gas controls for gas appliances, and ANSI Z21.80/CSA 6.22 for line pressure regulators. Provide shutoff valves conforming to ANSI Z21.15/CSA 9.1 for manually controlled gas shutoff valves and ANSI Z21.21/CSA 6.5 for automatic shutoff valves for gas appliances.

2.7 NATURAL GAS SERVICE

2.7.1 Service Regulators

a. Provide ferrous bodied pressure regulators for individual service lines, capable of reducing distribution line pressure to pressures required for users. Provide service regulators conforming to AGA ANSI B109.4 CGA-6.18-M95 with full capacity internal relief and overpressure shutoff. Set pressure relief at a lower pressure than would cause unsafe operation of any connected user.

b. Adjust regulators for liquified petroleum gas to 2.5 to 3 kPa 10 to 12 inches of water column, with pressure relief set at 4 kPa 16 inches of water column.

c. Provide regulator(s) having a single port with orifice diameter no greater than that recommended by the manufacturer for the maximum gas flow rate at the regulator inlet pressure. Provide regulator valve vent of resilient materials designed to withstand flow conditions when pressed against the valve port, capable of regulating downstream pressure within limits of accuracy and limiting the buildup of pressure under no-flow conditions to 50 percent or less of the discharge pressure maintained under flow conditions. Provide a self-contained service regulator, and pipe not exceeding exceed 2 inch size.

2.7.2 Gas Meter

AGA ANSI B109.1,AGA ANSI B109.2,AGA ANSI B109.3, pipe,pedestal mounted, diaphragm or bellow style, cast-iron, enamel-coated steel, aluminum case. Provided with a strainer immediately upstream. Provide diaphragm-type meter conforming to AGA ANSI B109.1 for required flow rates less than 500 cfh, or AGA ANSI B109.2, for flow rates 500 cfh and above, rotary-type displacement meter conforming to AGA ANSI B109.3, as required by local gas utility supplier. Provide combined odometer-type register totalizer index, UV-resistant index cover, water escape hole in housing, and means for sealing against tampering. Provide temperature-compensated type meters sized for the required volumetric flow rate and suitable for accurately measuring and handling gas at pressures, temperatures, and flow rates indicated. Provide meters with over-pressure protection as specified in 49 CFR 192 and ASME B31.8. Provide meters that are tamper-proof with frost protection, . Provide meters with a pulse switch initiator capable of operating up to speeds of 500 maximum pulses per minute with no false pulses and requiring no field adjustments. Provide not less than one pulse per 100 cubic feet of gas. Minimum service life must be 30,000,000 cycles.

2.7.2.1 Utility Monitoring and Control System (UMCS) / Energy Monitoring and Control (EMCS) or Automatic Meter Reading Interfaces

Provide gas meters capable of interfacing the output signal, equivalent to volumetric flow rate, with the existing UMCS / EMCS for data gathering in units of cubic meters cubic feet. Provide meters that do not require power to function and deliver data. Output signal must be either a voltage or amperage signal that can be converted to volumetric flow by using an appropriate scaling factor.

2.7.2.2 Measurement Configuration

For buildings that already have a gas meter with a pulse output, ensure that the pulse output is connected to a data gathering device (i.e. electric meter). For buildings where a natural gas meter already exists but does not have a pulse output, add a pulse kit to the existing meter and tie the output to a data gathering device. If the existing gas meter will not accept a pulse kit or if no meter exists a new natural gas meter must be installed, also requiring a pulse output to a data gathering device. Ensure the pulse frequency and electronic characteristics are compatible with the existing data gathering device, if any.

2.8 AUTOMATIC GAS SHUT-OFF

Provide low pressure automatic gas shutoff or excess flow valve (EFV) downstream of the point of delivery after the meter/regulator conforming to ANSI Z21.93/CSA 6.30 and UL listed or CSA listed or International Association of Plumbing and Mechanical Officials (IAPMO) listed. The EFV may be either a bypass (automatic reset) or a non-bypass type (manual reset). Provide low pressure automatic gas shutoff or excess flow valve (EFV) at each branch to an appliance.

2.9 BOLTING (BOLTS AND NUTS)

Stainless steel bolting; ASTM A193/A193M, Grade B8M or B8MA, Type 316, for bolts; and ASTM A194/A194M, Grade 8M, Type 316, for nuts. Dimensions of bolts, studs, and nuts must conform with ASME B18.2.1 and ASME B18.2.2

with coarse threads conforming to ASME B1.1, with Class 2A fit for bolts and studs and Class 2B fit for nuts. Bolts or bolt-studs must extend through the nuts and may have reduced shanks of a diameter not less than the diameter at root of threads. Bolts must have American Standard regular square or heavy hexagon heads; nuts must be American Standard heavy semifinished hexagonal.

2.10 GASKETS

Fluorinated elastomer, compatible with flange faces.

2.11 IDENTIFICATION FOR ABOVEGROUND PIPING

MIL-STD-101 for legends and type and size of characters. For pipes 3/4 inch od and larger, provide printed legends to identify contents of pipes and arrows to show direction of flow. Color code label backgrounds to signify levels of hazard. Make labels of plastic sheet with pressure-sensitive adhesive suitable for the intended application. For pipes smaller than 3/4 inch od, provide brass identification tags 1 1/2 inches in diameter with legends in depressed black-filled characters.

PART 3 EXECUTION

Gas service installation shall be in accordance with Central Hudson Gas and Electric Coporation installation requirements and West Point Engineering Planning Standards.

3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy or areas of conflict before performing the work.

3.2 EXCAVATION AND BACKFILLING

Provide required excavation, backfilling, and compaction as specified in Section 31 00 00 EARTHWORK.

3.3 GAS PIPING SYSTEM

Provide a gas piping system from the point of delivery, defined as the service connection at the gas main meter set assembly to the connections to each gas utilization device that is in compliance with NFPA 54.

3.3.1 Protection and Cleaning of Materials and Components

Protect equipment, pipe, and tube openings by closing with caps or plugs during installation. At the completion of all work, thoroughly clean the entire system.

3.3.2 Workmanship and Defects

Piping, tubing and fittings must be clear and free of cutting burrs and defects in structure or threading and must be thoroughly brushed and chip-and scale-blown. Repair of defects in piping, tubing or fittings is not allowed; replace defective items when found.

3.3.3 Service Lines

3.3.3.1 General

Construct service lines of PE or steel material and extend from a gas main to and including the point of delivery within 5 feet of the building. The point of delivery is the meter set assembly. Connect the service lines to the gas mains as indicated. Where indicated, provide service line with an isolation valve of the same size as the service line. Make the service lines as short and as straight as practicable between the point of delivery and the gas main, without bends or lateral curves unless necessary to avoid obstructions or otherwise permitted. Lay service lines with as few joints as practicable using standard lengths of pipe, use shorter lengths only for closures.

3.4 PROTECTIVE COVERING

3.4.1 Underground Metallic Pipe

Except as otherwise specified, apply protective coverings mechanically in a factory or field plant especially equipped for the purpose. Hand apply protective covering to valves and fittings that cannot be coated and wrapped mechanically, preferably at the plant that applies the covering to the pipe. Coat and wrap joints by hand, in a manner and with materials that produce a covering equal in thickness to that of the covering applied mechanically.

3.4.1.1 Thermoplastic Resin Coating System

Provide a thermoplastic coating system conforming to NACE SP0185, Type A. Clean the exterior of the pipe to a commercial grade blast cleaning finish in accordance with SSPC SP 6/NACE No.3, and apply adhesive compound to the pipe. Immediately after the adhesive is applied, extrude a seamless tube of polyethylene over the adhesive to produce a bonded seamless coating, with a nominal thickness of 10 mils (plus or minus 10 percent) of adhesive and 40 mils (plus or minus 10 percent) of polyethylene for pipes up to 16 inches in diameter. Apply joint coating and field repair material as recommended by the coating manufacturer, consisting of one the following:

a. Heat shrinkable polyethylene sleeves.
b. Polyvinyl chloride pressure-sensitive adhesive tape.
c. High density polyethylene/bituminous rubber compound tape.

Inspect the coating system for holes, voids, cracks, and other damage during installation.

3.4.1.2 Inspection of Pipe Coatings

Repair any damage to the protective covering during transit and handling before installation. After field coating and wrapping has been applied, inspect the entire pipe using an electric holiday detector with impressed current set at a value in accordance with NACE SP0274 using a full-ring, spring-type coil electrode. Equip the holiday detector with a bell, buzzer, or other type of audible signal which sounds when a holiday is detected. Immediately repair all holidays in the protective covering upon detection. The Contracting Officer reserves the right to inspect and determine the suitability of the detector. Furnish labor, materials, and equipemnt necessary for conducting the inspection.

3.4.2 Aboveground Metallic Piping Systems

3.4.2.1 Ferrous Surfaces

Touch up shop primed surfaces with ferrous metal primer. Solvent clean surfaces that have not been shop primed . Mechanically clean surfaces that contain loose rust, loose mill scale and other foreign substances by power wire brushing or commercial sand blasted conforming to SSPC SP 6/NACE No.3 and prime with ferrous metal primer or vinyl type wash coat. Finish primed surfaces with two coats of exterior oil paint or vinyl paint.

3.4.2.2 Nonferrous Surfaces

Except for aluminum alloy pipe, do not paint nonferrous surfaces. Paint surfaces of aluminum alloy pipe and fittings to protect against external corrosion where they contact masonry, plaster, insulation, or are subject to repeated wettings by such liquids as water, detergents or sewage. Solvent-clean the surfaces and treat with vinyl type wash coat. Apply a first coat of aluminum paint and a second coat of alkyd gloss enamel or silicone alkyd copolymer enamel.

3.5 INSTALLATION

Install the gas system in conformance with the manufacturer's recommendations and applicable provisions of NFPA 54, and as indicated. Perform all pipe cutting without damage to the pipe, with an approved type of mechanical cutter, unless otherwise authorized. Use wheel cutters where practicable. Cut thermoplastic and fiberglass pipe in accordance with AGA XR0603.

3.5.1 Metallic Piping Installation

Bury underground piping a minimum of 18 inches below grade. Make changes in direction of piping with fittings only; mitering or notching pipe to form elbows and tees or other similar type construction is not permitted. Branch connection may be made with either tees or forged branch outlet fittings. Provide branch outlet fittings which are forged, flared for improvement of flow where attached to the run, and reinforced against external strains. Do not use aluminum alloy pipe in exterior locations or underground.

3.5.2 Metallic Tubing Installation

Install metallic tubing using gas tubing fittings approved by the tubing manufacturer. CSST gas piping systems must be installed by contractors who have completed the manufacturer's training program as indicated on a certification card. Make branch connections with tees. Prepare all tubing ends with tools designed for that purpose. Do not use aluminum alloy tubing in exterior locations or underground. Maintain electrical continuity of gas piping system in accordance with NFPA 54, paragraph entitled 'Electrical Bonding and Grounding'.

3.5.3 Thermoplastic and Fiberglass Piping, Tubing, and Fittings

Installation of thermoplastic and fiberglass piping, tubing, and fittings is permitted only outside and underground. Bury piping a minimum of 18 inches below grade. Install the piping to avoid excessive stresses due to thermal contraction, and use only where indicated. Installations must be

made using qualified procedures, by qualified installers, and in compliance with AGA XR0603 and NFPA 54, and must be inspected by a qualified inspector.

3.5.4 Connections Between Metallic and Plastic Piping

Connections between metallic and plastic piping are only allowed outside, underground, and with approved transition fittings.

3.5.5 Piping and Tubing Buried Under Buildings

Run underground piping and tubing installed beneath buildings within a water tight plastic conduit or as part of a listed encasement system. Extend casing or encasement system at least 4 inches outside the building, and provide the pipe with spacers and end bushings to seal at both ends to prevent the entrance of water and/or the escape of gas. Extend a vent line from the annular space above grade outside to a point where gas will not be a hazard, and terminate in a rain/insect-resistant fitting.

3.5.6 Concealed Piping in Buildings

Do not use combinations of fittings (unions, tubing fittings, running threads, right- and left-hand couplings, bushings, and swing joints) to conceal piping within buildings.

3.5.6.1 Piping and Tubing in Partitions

Locate concealed piping and tubing in hollow, rather than solid, partitions. Protect tubing passing through walls or partitions against physical damage both during and after construction, and provide appropriate safety markings and labels. Provide protection of concealed pipe and tubing in accordance with ANSI LC 1/CSA 6.26.

3.5.6.2 Piping in Floors

Lay piping in solid floors except where embedment in concrete is indicated in channels suitably covered to permit access to the piping with minimum damage to the building. Surround piping embedded in concrete by a minimum of 1-1/2 inches of concrete and do not allow physical contact with other metallic items such as reinforcing rods or electrically neutral conductors. Do not embed piping in concrete slabs containing quickset additives or cinder aggregate.

3.5.7 Aboveground Piping

Run aboveground piping as straight as practicable along the alignment and elevation indicated, with a minimum of joints, and separately supported from other piping system and equipment. Install exposed horizontal piping no farther than 6 inches from nearest parallel wall and at an elevation which prevents standing, sitting, or placement of objects on the piping.

3.5.8 Final Gas Connections

Unless otherwise specified, make final connections with rigid metallic pipe and fittings. Make final connections to kitchen ranges using flexible connectors not less than 40 inch long, to afford access to coupling and to permit movement of equipment for cleaning. Flexible connectors may be used for final connections to residential dryers. Flexible connectors may be used for final connections to gas utilization equipment. In addition to cautions listed in instructions required by

ANSI standards for flexible connectors, insure that flexible connectors do not pass through equipment cabinet. Provide accessible gas shutoff valve and coupling for each gas equipment item.

3.6 PIPE JOINTS

Design and install pipe joints to effectively sustain the longitudinal pull-out forces caused by contraction of the piping or superimposed loads.

3.6.1 Threaded Metallic Joints

Provide threaded joints in metallic pipe with tapered threads evenly cut and made with UL approved graphite joint sealing compound for gas service or tetrafluoroethylene tape applied to the male threads only. Threaded joints up to 1-1/2 inches in diameter may be made with approved tetrafluoroethylene tape. Threaded joints up to 2 inches in diameter may be made with approved joint sealing compound. After cutting and before threading, ream pipe and remove all burrs. Caulking of threaded joints to stop or prevent leaks is not permitted.

3.6.2 Welded Metallic Joints

Perform gas pipe weldments, as indicated, by welders who have submitted certificates on file with the Contracting Officer to conform to this specification and as required in 49 CFR 192 and ASME B31.8. Make changes in direction of piping by welding fittings only; mitering or notching pipe to form elbows and tees or other similar type construction is not permitted. Branch connection may be made with either welding tees or forged branch outlet fittings. Use forged or flared branch outlet fittings for improvement of flow where attached to the run, and reinforced against external strains. Perform all beveling, alignment, and heat treatment in accordance with 49 CFR 192 and ASME B31.8. Remove weld defects and repair the weld, or remove the weld joints entirely and reweld. After filler metal has been removed from its original package, protect it or store so that its characteristics or welding properties are not affected adversely. Do not use electrodes that have been wetted or have lost any of their coating. Perform inspection of welds in accordance with 49 CFR 192, Subpart E, and ASME B31.8.

3.6.3 Thermoplastic and Fiberglass Joints

3.6.3.1 Thermoplastic and Fiberglass

Conform jointing procedures to AGA XR0603. Do not make joints with solvent cement or heat of fusion between different kinds of plastics.

3.6.3.2 PE Fusion Welding Inspection

Visually inspect butt joints by comparing with, manufacturer's visual joint appearance chart. Inspect fusion joints for proper fused connection. Replace defective joints by cutting out defective joints or replacing fittings. Inspect, in conformance with API 570, 100 percent of all joints and re-inspect all corrections. Arrange with the pipe manufacturer's representative in the presence of the Contracting Officer to make first time inspection.

3.6.4 Flared Metallic Tubing Joints

Make flared joints in metallic tubing with special tools recommended by

the tubing manufacturer. Use flared joints only in systems constructed from nonferrous pipe and tubing, when experience or tests have demonstrated that the joint is suitable for the conditions, and when adequate provisions are made in the design to prevent separation of the joints. Do not use metallic ball sleeve compression-type tubing fittings for tubing joints.

3.6.5 Solder or Brazed Joints

Make all joints in metallic tubing and fittings with materials and procedures recommended by the tubing supplier. Braze joints with material having a melting point above 1000 degrees F, containing no phosphorous.

3.6.6 Joining Thermoplastic or Fiberglass to Metallic Piping or Tubing

When compression type mechanical joints are used, provide gasket material in the fittings compatible with the plastic piping and with the gas in the system. Use an internal tubular rigid stiffener in conjunction with the fitting, flush with end of the pipe or tubing, extending at least to the outside end of the compression fitting when installed. Remove all rough or sharp edges from stiffener. Do not force fit stiffener in the plastic. Split tubular stiffeners are not allowed.

3.6.7 Press Connections

Make press connections in accordance with manufacturer's installation instructions using tools approved by the manufacturer. Fully insert the tubing into the fitting and then mark at the shoulder of the fitting. Check the fitting alignment against the mark on the tubing to assure the tubing is fully inserted before the joint is pressed.

3.7 PIPE SLEEVES

Provide pipes passing through concrete or masonry walls or concrete floors or roofs with pipe sleeves fitted into place at the time of construction. Do not install sleeves in structural members except where indicated or approved. Make all rectangular and square openings as detailed. Extend each sleeve through its respective wall, floor or roof, and cut flush with each surface, except in mechanical room floors not located on grade where clamping flanges or riser pipe clamps are used. Extend sleeves in mechanical room floors above grade at least 4 inches above finish floor. Unless otherwise indicated, use sleeves large enough to provide a minimum clearance of 1/4 inch all around the pipe. Provide steel pipe for sleeves in bearing walls, waterproofing membrane floors, and wet areas . Provide sleeves in nonbearing walls, floors, or ceilings of steel pipe, galvanized sheet metal with lock-type longitudinal seam, or moisture-resistant fiber or plastic. For penetrations of fire walls, fire partitions and floors which are not on grade, seal the annular space between the pipe and sleeve with fire-stopping material and sealant that meet the requirement of Section 07 84 00 FIRESTOPPINGG.

3.8 PIPES PENETRATING WATERPROOFING MEMBRANES

Install pipes penetrating waterproofing membranes as specified in Section 22 00 00 PLUMBING, GENERAL PURPOSE.

3.9 FIRE SEAL

Fire seal all penetrations of fire rated partitions, walls and floors in

accordance with Section 07 84 00 FIRESTOPPING.

3.10 ESCUTCHEONS

Provide escutcheons for all finished surfaces where gas piping passes through floors, walls, or ceilings except in boiler, utility, or equipment rooms.

3.11 SPECIAL REQUIREMENTS

Provide drips, grading of the lines, freeze protection, and branch outlet locations as shown and conforming to the requirements of NFPA 54.

3.12 BUILDING STRUCTURE

Do not weaken any building structure by the installation of any gas piping. Do not cut or notch beams, joists or columns. Attach piping supports to metal decking. Do not attach supports to the underside of concrete filled floors or concrete roof decks unless approved by the Contracting Officer.

3.13 PIPING SYSTEM SUPPORTS

Support gas piping systems in buildings with pipe hooks, metal pipe straps, bands or hangers suitable for the size of piping or tubing. Do not support any gas piping system by other piping. Conform spacing of supports in gas piping and tubing installations to the requirements of NFPA 54. Conform the selection and application of supports in gas piping and tubing installations to the requirements of MSS SP-58. In the support of multiple pipe runs on a common base member, use a clip or clamp where each pipe crosses the base support member. Spacing of the base support members is not to exceed the hanger and support spacing required for any of the individual pipes in the multiple pipe run. Rigidly connect the clips or clamps to the common base member. Provide a clearance of 1/8 inch between the pipe and clip or clamp for all piping which may be subjected to thermal expansion.

3.14 ELECTRICAL BONDING AND GROUNDING

Provide a gas piping system within the building that is electrically continuous and bonded to a grounding electrode as required by NFPA 54 and NFPA 70.

3.15 SHUTOFF VALVE

Install the main gas shutoff valve controlling the gas piping system to be easily accessible for operation, as indicated, protected from physical damage, and marked with a metal tag to clearly identify the piping system controlled. Install valves approximately at locations indicated. Orient stems vertically, with operators on top, or horizontally. Provide stop valve on service branch at connection to main and shut-off valve on riser outside of building.

3.16 LINE AND APPLIANCE PRESSURE REGULATORS

Install line pressure regulators and appliance regulators in accordance with the manufacturer's requirements and in accordance with NFPA 54. Install each regulator in an accessible location and install shutoff valves ahead of each line and appliance regulator to allow for

maintenance. Where vent limiting devices are not included in the regulators, install a vent pipe to the exterior of the building. Terminate all service regulator vents and relief vents in the outside air in rain and insect resistant fittings. Locate the open end of the vent where gas can escape freely into the atmosphere, away from any openings into the building and above areas subject to flooding.

3.17 GAS SERVICE INSTALLATION

Install site underground gas service and associated materials in accordance with Central Hudson Gas and Electric Corporation installation requirements and West Point Engineering Planning Standards. Design valve installation in plastic pipe to protect the plastic pipe against excessive torsional or shearing loads when the valve is operated and from other stresses which may be exerted through the valve or valve box. Install gas piping, appliances, and equipment in conformance with the manufacturer's recommendations, applicable provisions of NFPA 54 and AGA XR0603, and as indicated. Installations must be in accordance with 49 CFR 192 and ASME B31.8. Contractor must submit and use only tested and approved work procedures. Contractor must use only welders and jointers who have been recently qualified by training and test for joining and installing the gas pipe material used on this job. The finished product must be inspected by a person qualified to inspect joints made by the particular procedures used to make joints.

3.17.1 Service Line

Install service line, branch connection to the main, and riser in accordance with 49 CFR 192 and ASME B31.8. Provide a minimum of 18 inches cover or encase the service line so that it is protected. Install service line so that no undue stress is applied to the pipe, connection, or riser. Install approved riser and terminate with an approved isolation valve, EFV and automatic shutoff device. After laying of pipe and testing, backfill the trench in accordance with Section 31 00 00 EARTHWORK.

Were steel pipe is used as service line, install corrosion prevention coating and cathodic protect for the steel service line. Where connected to an existing cathodically protected steel pipe, ensure electrical continuity from the riser to the branch connection to the main. Install a dielectric fitting on the riser to prevent electrical continuity to the above ground piping.

Where plastic pipe is used as the service line, make joints in accordance with procedures qualified by test. Personnel joining plastic pipe must be qualified by making a satisfactory specimen joint that passes the required inspection and test listed in 49 CFR 192.285. Inspection must be made by inspectors qualified in evaluating joints made under the specific joining procedure, as required by 49 CFR 192.287.

3.17.2 Service Regulator

Install service regulator in accordance with 49 CFR 192 and ASME B31.8 and this specification ensuring that the customer's piping is protected from over pressurization should the service regulator fail. A 3/8 inch tapped fitting equipped with a plug must be provided on both sides of the service regulator for installation of pressure gauges for adjusting the regulator. For inside installations, route the regulator vent pipe through the exterior wall to the atmosphere, and seal building penetrations for service line and vent. Terminate the regulator vent so

that it is protected from precipitation and insect intrusion, so that it is not submerged during floods, and so that gas escaping will not create a hazard or enter the building through openings.

3.17.3 Gas Meter

Install shutoff valve, meter set assembly, and service regulator on the service line outside the building a minimum of 3 feet from any potential ignition source, 18 inches above the ground on the riser. An insulating joint (dielectric connection) must be installed on the inlet side of the meter set assembly and service regulator and must be constructed to prevent flow of electrical current.

3.17.4 Valve Boxes

Provide valve boxes of cast iron not less than 3/16 inch thick at each underground valve except where concrete or other type of housing is indicated. Provide valve boxes with locking covers that require a special wrench for removal, and furnish the correctly marked wrench for each box. Cast the word "gas" in the box cover. When the valve is located in a roadway, protect the valve box by a suitable concrete slab at least 3 square feet. When in a sidewalk, provide the top of the box as a removable concrete slab 2 feet square and set flush with the sidewalk. Make the boxes adjustable extension type with screw or slide-type adjustments. Separately support valve boxes to not rest on the pipe, so that no traffic loads can be transmitted to the pipe. Only locate valves valve boxes or inside of buildings.

3.18 CATHODIC PROTECTION

Provide cathodic protection for underground ferrous gas piping as specified in UFC 3-570-01. .

3.19 TESTING

Submit test procedures and reports in booklet form tabulating test and measurements performed; dated after award of this contract, and stating the Contractor's name and address, the project name and location, and a list of the specific requirements which are being certified. Test entire gas piping system to ensure that it is gastight prior to putting into service. Prior to testing, purge the system, clean, and clear all foreign material. Test each joint with an approved gas detector, soap and water, or an equivalent nonflammable solution. Inspect and test each valve in conformance with API Std 598 and API Std 607. Complete testing before any work is covered, enclosed, or concealed, and perform with due regard for the safety of employees and the public during the test. Install bulkheads, anchorage and bracing suitably designed to resist test pressures if necessary, and as directed and or approved by the Contracting Officer. Do not use oxygen as a testing medium.

3.19.1 Pressure Tests

Submit test procedures and reports in booklet form tabulating test and measurements performed; dated after award of this contract, and stating the Contractor's name and address, the project name and location, and a list of the specific requirements which are being certified. Before appliances are connected, test by filling the piping systems with air or an inert gas to withstand a minimum pressure of 3 pounds gauge for a period of not less than 10 minutes as specified in NFPA 54 without showing

any drop in pressure. Do not use Oxygen for test. Measure pressure with a mercury manometer, slope gauge, or an equivalent device calibrated to be read in increments of not greater than 0.1 pound. Isolate the source of pressure before the pressure tests are made.

3.19.2 Test With Gas

Before turning on gas under pressure into any piping, close all openings from which gas can escape. Immediately after turning on the gas, check the piping system for leakage by using a laboratory-certified gas meter, an appliance orifice, a manometer, or equivalent device. Conform all testing to the requirements of NFPA 54. If leakage is recorded, shut off the gas supply, repair the leak , and repeat the tests until all leaks have been stopped.

3.19.3 Purging

After testing is completed, and before connecting any appliances, fully purge all gas piping. Do not purge piping into the combustion chamber of an appliance. Do not purge the open end of piping systems into confined spaces or areas where there are ignition sources unless the safety precautions recommended in NFPA 54 are followed.

3.19.4 Labor, Materials and Equipment

Furnish all labor, materials and equipment necessary for conducting the testing and purging.

3.20 PIPE COLOR CODE MARKING

Provide color code marking of piping as specified in Section 09 90 00 PAINTS AND COATINGS, conforming to ASME A13.1.

-- End of Section --

SECTION 23 64 26

CHILLED, CHILLED-HOT, AND CONDENSER WATER PIPING SYSTEMS
08/09

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z21.22/CSA 4.4	(2015) Relief Valves for Hot Water Supply Systems

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1003	(2009) Performance Requirements for Water Pressure Reducing Valves for Domestic Water Distribution Systems - (ANSI approved 2010)
ASSE 1017	(2009) Performance Requirements for Temperature Actuated Mixing Valves for Hot Water Distribution Systems - (ANSI approved 2010)

AMERICAN WELDING SOCIETY (AWS)

AWS A5.8/A5.8M	(2019) Specification for Filler Metals for Brazing and Braze Welding
AWS BRH	(2007; 5th Ed) Brazing Handbook
AWS D1.1/D1.1M	(2020) Structural Welding Code - Steel
AWS Z49.1	(2012) Safety in Welding and Cutting and Allied Processes

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.20.1	(2013; R 2018) Pipe Threads, General Purpose (Inch)
ASME B16.1	(2015) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250
ASME B16.3	(2016) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.9	(2018) Factory-Made Wrought Buttwelding Fittings
ASME B16.11	(2016) Forged Fittings, Socket-Welding and Threaded

ASME B16.18	(2018) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.21	(2016) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.22	(2018) Standard for Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.26	(2018) Standard for Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B16.39	(2020) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300
ASME B31.9	(2017) Building Services Piping
ASME B40.100	(2013) Pressure Gauges and Gauge Attachments
ASME BPVC SEC IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2020) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A653/A653M	(2020) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A733	(2016) Standard Specification for Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples
ASTM B32	(2008; R 2014) Standard Specification for Solder Metal
ASTM B42	(2015a) Standard Specification for Seamless Copper Pipe, Standard Sizes
ASTM B62	(2017) Standard Specification for Composition Bronze or Ounce Metal Castings
ASTM B75/B75M	(2011) Standard Specification for Seamless Copper Tube
ASTM B88	(2020) Standard Specification for Seamless Copper Water Tube
ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus

ASTM B813	(2016) Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube
ASTM D520	(2000; R 2011) Zinc Dust Pigment
ASTM D3308	(2012; R 2017) Standard Specification for PTFE Resin Skived Tape
ASTM E84	(2020) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM F1007	(2018) Standard Specification for Pipeline Expansion Joints of the Packed Slip Type for Marine Application
ASTM F1120	(1987; R 2015) Standard Specification for Circular Metallic Bellows Type Expansion Joints for Piping Applications
ASTM F1199	(1988; R 2015) Cast (All Temperatures and Pressures) and Welded Pipe Line Strainers (150 psig and 150 degrees F Maximum)

EXPANSION JOINT MANUFACTURERS ASSOCIATION (EJMA)

EJMA Stds	(2015) (10th Ed) EJMA Standards

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-25	(2018) Standard Marking System for Valves, Fittings, Flanges and Unions
MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-67	(2017; Errata 1 2017) Butterfly Valves
MSS SP-69	(2003; Notice 2012) Pipe Hangers and Supports - Selection and Application (ANSI Approved American National Standard)
MSS SP-70	(2011) Gray Iron Gate Valves, Flanged and Threaded Ends
MSS SP-71	(2018) Gray Iron Swing Check Valves, Flanged and Threaded Ends
MSS SP-72	(2010a) Ball Valves with Flanged or Butt-Welding Ends for General Service
MSS SP-78	(2011) Cast Iron Plug Valves, Flanged and Threaded Ends
MSS SP-80	(2013) Bronze Gate, Globe, Angle and Check Valves

MSS SP-85	(2011) Gray Iron Globe & Angle Valves Flanged and Threaded Ends
MSS SP-110	(2010) Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2018) Motors and Generators
NEMA MG 11	(1977; R 2012) Energy Management Guide for Selection and Use of Single Phase Motors

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 90A	(2018) Standard for the Installation of Air Conditioning and Ventilating Systems

1.2 SYSTEM DESCRIPTION

Provide the water systems having the minimum service (design) temperature-pressure rating indicated. Provision of the piping systems, including materials, installation, workmanship, fabrication, assembly, erection, examination, inspection, and testing shall be in accordance with the required and advisory provisions of ASME B31.9 except as modified or supplemented by this specification section or design drawings. This specification section covers the water systems piping which is located within, on, and adjacent to building(s) within the building(s) 5 foot line.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance with Section 01 33 29 SUSTAINABILITY REPORTING. Submittals with an "AE" are for submittal to the Designer of Record. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Calibrated Balancing Valves; G, AE

~~Pump Discharge Valve~~

Water Temperature Mixing Valve; G, AE

Water Temperature Regulating Valves; G, AE

Water Pressure Reducing Valve

Pressure Relief Valve

Combination Pressure and Temperature Relief Valves

Expansion Joints; G, AE

Combination Strainer and Pump Suction Diffuser

Expansion Tanks

Air Separator Tanks

SD-06 Test Reports

Piping Welds NDE Report

Pressure Tests Reports; G, AE

Report shall be provided in bound 8-1/2 by 11 inch booklets. In the reports, document all phases of the tests performed. Include initial test summaries, all repairs/adjustments made, and the final test results.

SD-07 Certificates

Employer's Record Documents (For Welding)

Welding Procedures and Qualifications

Certificates shall be submitted for the following items showing conformance with the referenced standards contained in this section.

SD-08 Manufacturer's Instructions

Lesson plan for the Instruction Course; G, AE

SD-10 Operation and Maintenance Data

Requirements for data packages are specified Section 01 78 23 OPERATION AND MAINTENANCE DATA, except as supplemented and modified by this specification section.

Submit spare parts data for each different item of equipment specified, with operation and maintenance data packages. Include a complete list of parts and supplies, with current unit prices and source of supply, a recommended spare parts list for 1 year of operation, and a list of the parts recommended by the manufacturer to be replaced on a routine basis.

Submit a list of qualified permanent service organizations with operation and maintenance data packages. Include service organization addresses and service area or expertise. The service organizations shall be reasonably convenient to the equipment installation and be able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

Calibrated Balancing Valves, Data Package 3; G, AE

~~Pump Discharge Valve, Data Package 2; G, AE~~

Water Temperature Mixing Valve, Data Package 3; G, AE

Water Temperature Regulating Valves, Data Package 3; G, AE

Water Pressure Reducing Valve, Data Package 3; G, AE

Pressure Relief Valve, Data Package 2; G, AE

Combination Pressure and Temperature Relief Valves, Data Package 2; G, AE

Expansion Joints, Data Package 2; G, AE

Combination Strainer and Pump Suction Diffuser, Data Package 2; G, RO

Expansion Tanks, Data Package 2; G, AE

Air Separator Tanks, Data Package 2; G, AE

1.4 MODIFICATIONS TO REFERENCES

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction", or words of similar meaning, to mean the Contracting Officer.

1.4.1 Definitions

For the International Code Council (ICC) Codes referenced in the contract documents, advisory provisions shall be considered mandatory, the word "should" shall be interpreted as "shall." Reference to the "code official" shall be interpreted to mean the "Contracting Officer." For Army owned property, references to the "owner" shall be interpreted to mean the "Contracting Officer." For leased facilities, references to the "owner" shall be interpreted to mean the "lessor." References to the "permit holder" shall be interpreted to mean the "Contractor."

1.4.2 Administrative Interpretations

For ICC Codes referenced in the contract documents, the provisions of Chapter 1, "Administrator," do not apply. These administrative requirements are covered by the applicable Federal Acquisition Regulations (FAR) included in this contract and by the authority granted to the Officer in Charge of Construction to administer the construction of this project. References in the ICC Codes to sections of Chapter 1, shall be applied appropriately by the Contracting Officer as authorized by his administrative cognizance and the FAR.

1.5 SAFETY REQUIREMENTS

Exposed moving parts, parts that produce high operating temperature, parts which may be electrically energized, and parts that may be a hazard to operating personnel shall be insulated, fully enclosed, guarded, or fitted with other types of safety devices. Safety devices shall be installed so that proper operation of equipment is not impaired.

1.6 DELIVERY, STORAGE, AND HANDLING

Protect stored items from the weather, humidity and temperature

variations, dirt and dust, or other contaminants. Proper protection and care of all material both before and during installation shall be the Contractor's responsibility. Any materials found to be damaged shall be replaced at the Contractor's expense. During installation, cap piping and similar openings to keep out dirt and other foreign matter. Any porous materials found to be contaminated with mold or mildew will be replaced at the Contractor's expense. Non-porous materials found to be contaminated with mold or mildew will be disinfected and cleaned prior to installation.

1.7 PROJECT/SITE CONDITIONS

1.7.1 Verification of Dimensions

The Contractor shall become familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

1.7.2 Drawings

Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories that may be required. The Contractor shall carefully investigate the plumbing, fire protection, electrical, structural and finish conditions that would affect the work to be performed and shall arrange such work accordingly, furnishing required offsets, fittings, and accessories to meet such conditions.

1.7.3 Accessibility

Install all work so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible. Install concealed valves, expansion joints, controls, dampers, and equipment requiring access, in locations freely accessible through access doors.

PART 2 PRODUCTS

2.1 STANDARD COMMERCIAL PRODUCTS

Materials and equipment shall be standard products of a manufacturer regularly engaged in the manufacturing of such products, which are of a similar material, design and workmanship. The standard products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening.

The two year use shall include applications of equipment and materials under similar circumstances and of similar size. The 2 years experience shall be satisfactorily completed by a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturer's catalogs, or brochures.

Products having less than a 2 year field service record shall be acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown. System components shall be environmentally suitable for the indicated locations.

The equipment items shall be supported by service organizations. These service organizations shall be reasonably convenient to the equipment installation and able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

2.2 STEEL PIPING

Water piping shall be steel pipe or copper tubing. Provide steel piping with a ANSI/ASME Class 125 service rating, which for 150 degrees F, the pressure rating is 175 psig.

2.2.1 Pipe

Steel pipe, conform to ASTM A53/A53M, Schedule 40, Type E or S, Grades A or B. Do not use Type F pipe.

2.2.2 Fittings and End Connections (Joints)

Piping and fittings 1 inch and smaller shall have threaded connections. Piping and fittings larger than 1 inch and smaller than 3 inches shall have either threaded or welded connections. Piping and fittings 3 inches and larger shall have welded or flanged connections. The manufacturer of each fitting shall be permanently identified on the body of the fitting in accordance with MSS SP-25.

2.2.2.1 Threaded Connections

Use threaded valves and pipe connections conforming to ASME B1.20.1. Used threaded fitting conforming to ASME B16.3. Use threaded unions conforming to ASME B16.39. Use threaded pipe nipples conforming to ASTM A733.

2.2.2.2 Flanged Connections

Flanges shall conform to ASME B16.1, Class 125. Gaskets shall be nonasbestos compressed material in accordance with ASME B16.21, 1/16 inch thickness, full face or self-centering flat ring type. These gaskets shall contain aramid fibers bonded with styrene butadeine rubber (SBR) or nitrile butadeine rubber (NBR). Bolts, nuts, and bolt patterns shall conform to ASME B16.1.

2.2.2.3 Welded Connections

Welded valves and pipe connections (both butt-welds and socket-welds types) shall conform to ASME B31.9. Butt-welded fittings shall conform to ASME B16.9. Socket-welded fittings shall conform to ASME B16.11. Welded fittings shall be identified with the appropriate grade and marking symbol.

2.2.2.4 Dielectric Waterways and Flanges

Provide dielectric waterways with a water impervious insulation barrier capable of limiting galvanic current to 1 percent of short circuit current in a corresponding bimetallic joint. When dry, insulation barrier shall be able to withstand a 600-volt breakdown test. Provide dielectric waterways constructed of galvanized steel and have threaded end connections to match connecting piping. Dielectric waterways shall be suitable for the required operating pressures and temperatures. Provide dielectric flanges with the same pressure ratings as standard flanges and provide complete electrical isolation between connecting pipe and/or equipment as described herein for dielectric waterways.

2.3 COPPER TUBING

Provide copper tubing and fittings with a ANSI/ASME Class 125 service

rating, which for 150 degrees F., the pressure rating is 175 psig.

2.3.1 Tube

Use copper tube conforming to ASTM B88, Type L or M for aboveground tubing, and Type K for buried tubing.

2.3.2 Fittings and End Connections (Solder and Flared Joints)

Wrought copper and bronze solder joint pressure fittings, including unions ands flanges, shall conform to ASME B16.22 and ASTM B75/B75M. Provide adapters as required. Cast copper alloy solder-joint pressure fittings , including unions and flanges, shall conform to ASME B16.18. Cast copper alloy fittings for flared copper tube shall conform to ASME B16.26 and ASTM B62. ASTM B42 copper pipe nipples with threaded end connections shall conform to ASTM B42.

Copper tubing of sizes larger than 4 inches shall have brazed joints. Brass or bronze adapters for brazed tubing may be used for connecting tubing to flanges and to threaded ends of valves and equipment.

Extracted brazed tee joints may be used if produced with an acceptable tool and installed in accordance with tool manufacturer's written procedures.

2.3.3 Solder

Provide solder in conformance with ASTM B32, grade Sb5, tin-antimony alloy. Solder flux shall be liquid or paste form, non-corrosive and conform to ASTM B813.

2.3.4 Brazing Filler Metal

Filler metal shall conform to AWS A5.8/A5.8M, Type BAg-5 with AWS Type 3 flux, except Type BCuP-5 or BCuP-6 may be used for brazing copper-to-copper joints.

2.4 VALVES

Provide valves with a ANSI/ASME Class 125 service rating, which for 150 degrees F, the pressure rating is 175 psig.

Valves in sizes larger than 1 inch and used on steel pipe systems, may be provided with rigid grooved mechanical joint ends. Such grooved end valves shall be subject to the same requirements as rigid grooved mechanical joints and fittings and, shall be furnished by the same manufacturer as the grooved pipe joint and fitting system.

2.4.1 Gate Valve

Gate valves 2-1/2 inches and smaller shall conform to MSS SP-80 Class 125 and shall be bronze with wedge disc, rising stem and threaded, soldered, or flanged ends. Gate valves 3 inches and larger shall conform to MSS SP-70, Class 125, cast iron with bronze trim, outside screw and yoke, and flanged or threaded ends.

2.4.2 Globe and Angle Valve

Globe and angle valves 2-1/2 inches and smaller shall conform to MSS SP-80,

Class 125. Globe and angle valves 3 inches and larger shall conform to MSS SP-85, Class 125.

2.4.3 Check Valve

Check valves 2-1/2 inches and smaller shall conform to MSS SP-80. Check valves 3 inches and larger shall conform to MSS SP-71, Class 125.

2.4.4 Butterfly Valve

Butterfly valves shall conform to MSS SP-67, Type 1 and shall be either the wafer or lug type. Valves smaller than 8 inches shall have throttling handles with a minimum of seven locking positions. Valves 8 inches and larger shall have totally enclosed manual gear operators with adjustable balance return stops and position indicators.

2.4.5 Plug Valve

Plug valves 2 inches and larger shall conform to MSS SP-78, have flanged or threaded ends, and have cast iron bodies with bronze trim. Valves 2 inches and smaller shall be bronze with NPT connections for black steel pipe and brazed connections for copper tubing. Valve shall be lubricated, non-lubricated, or tetrafluoroethylene resin-coated type. Valve shall be resilient, double seated, trunnion mounted with tapered lift plug capable of 2-way shutoff. Valve shall operate from fully open to fully closed by rotation of the handwheel to lift and turn the plug. Valve shall a weatherproof operators with mechanical position indicators. Valves 8 inches or larger shall be provided with manual gear operators with position indicators.

2.4.6 Ball Valve

Full port design. Ball valves 1/2 inch and larger shall conform to MSS SP-72 or MSS SP-110 and shall be cast iron or bronze with threaded, soldered, or flanged ends. Valves 8 inches or larger shall be provided with manual gear operators with position indicators. Ball valves may be provided in lieu of gate valves.

2.4.7 Square Head Cocks

Provide copper alloy or cast-iron body with copper alloy plugs, suitable for 125 psig water working pressure.

2.4.8 Calibrated Balancing Valves

Copper alloy or cast iron body, copper alloy or stainless internal working parts. Provide valve calibrated so that flow can be determined when the temperature and pressure differential across valve is known. Valve shall have an integral pointer which registers the degree of valve opening. Valve shall function as a service valve when in fully closed position. Valve shall be constructed with internal seals to prevent leakage and shall be supplied with preformed insulation.

Provide valve bodies with tapped openings and pipe extensions with positive shutoff valves outside of pipe insulation. The pipe extensions shall be provided with quick connecting hose fittings for a portable differential pressure meter connections to verify the pressure differential. Provide metal tag on each valve showing the gallons per minute flow for each differential pressure reading. In lieu of the

balancing valve with integral metering connections, a ball valve or plug valve with a separately installed orifice plate or venturi tube may be used for balancing.

~~2.4.9 Pump Discharge Valve~~

~~Valve shall shall perform the functions of a nonslam check valve, a manual balancing valve, and a shutoff. Valve shall be of cast iron or ductile iron construction with bronze and/or stainless steel accessories. Provide an integral pointer on the valve which registers the degree of valve opening. Flow through the valve shall be manually adjustable from bubble tight shutoff to full flow. Valves smaller than 2 inches shall have NPT connections. Valves 2 inches and larger shall have flanged or grooved end connections. Valve design shall allow the back seat for the stem to be replaced in the field under full line pressure.~~

2.4.9 Water Temperature Mixing Valve

Valve, ASSE 1017 for water service.

2.4.10 Water Temperature Regulating Valves

Provide copper alloy body, direct acting, pilot operated, for the intended service.

2.4.11 Water Pressure Reducing Valve

Valve, ASSE 1003 for water service, copper alloy body.

2.4.12 Pressure Relief Valve

Valve shall prevent excessive pressure in the piping system when the piping system reaches its maximum heat buildup. Valve, ANSI Z21.22/CSA 4.4 and shall have cast iron bodies with corrosion resistant internal working parts. The discharge pipe from the relief valve shall be the size of the valve outlet unless otherwise indicated.

2.4.13 Combination Pressure and Temperature Relief Valves

ANSI Z21.22/CSA 4.4, copper alloy body, automatic re-seating, test lever, and discharge capacity based on AGA temperature steam rating.

2.4.14 Float Valve

Angle pattern and Globe pattern. Valve bodies 3 inches nominal pipe size and smaller shall be bronze. Valve bodies larger than 3 inches shall be cast iron or bronze. Steel parts shall be corrosion resistant. Where float rods are extended for tank applications, extension shall be properly supported and guided to avoid bending of float rod or stressing of valve pilot linkage.

2.4.15 Drain Valves

Valves, MSS SP-80 gate valves. Valve shall be manually-operated, 3/4 inch pipe size and above with a threaded end connection. Provide valve with a water hose nipple adapter. Freeze-proof type valves shall be provided in installations exposed to freezing temperatures.

2.4.16 Air Venting Valves

Manually-operated general service type air venting valves, brass or bronze valves that are furnished with threaded plugs or caps. Automatic type air venting shall be the ball-float type with brass/bronze or brass bodies, 300 series corrosion-resistant steel float, linkage and removable seat. Air venting valves on water coils shall have not less than 1/8 inch threaded end connections. Air venting valves on water mains shall have not less than 3/4 inch threaded end connections. Air venting valves on all other applications shall have not less than 1/2 inch threaded end connections.

2.4.17 Vacuum Relief Valves

ANSI Z21.22/CSA 4.4

2.5 PIPING ACCESSORIES

2.5.1 Strainer

Strainer, ASTM F1199, except as modified and supplemented in this specification. Strainer shall be the cleanable, basket or "Y" type, the same size as the pipeline. Strainer bodies shall be fabricated of cast iron with bottoms drilled, and tapped. Provide blowoff outlet with pipe nipple, gate valve, and discharge pipe nipple. The bodies shall have arrows clearly cast on the sides indicating the direction of flow.

Provide strainer with removable cover and sediment screen. The screen shall be made of minimum 22 gauge corrosion-resistant steel, with small perforations numbering not less than 400 per square inch to provide a net free area through the basket of at least 3.30 times that of the entering pipe. The flow shall be into the screen and out through the perforations.

2.5.2 Cyclonic Separator

Metal- bodied, with removal capability of removing solids 45 microns/325 mesh in size and heavier than 1.20 specific gravity, maximum pressure drop of 5 psid, with cleanout connection.

2.5.3 Combination Strainer and Pump Suction Diffuser

Angle type body with removable strainer basket and internal straightening vanes, a suction pipe support, and a blowdown outlet and plug. Strainer shall be in accordance with ASTM F1199, except as modified and supplemented by this specification. Unit body shall have arrows clearly cast on the sides indicating the direction of flow.

Strainer screen shall be made of minimum 22 gauge corrosion-resistant steel, with small perforations numbering not less than 400 per square inch to provide a net free area through the basket of at least 3.30 times that of the entering pipe. Flow shall be into the screen and out through the perforations. Provide an auxiliary disposable fine mesh strainer which shall be removed 30 days after start-up. Provide warning tag for operator indicating scheduled date for removal.

Casing shall have connection sizes to match pump suction and pipe sizes, and be provided with adjustable support foot or support foot boss to relieve piping strains at pump suction. Provide unit casing with blowdown port and plug. Provide a magnetic insert to remove debris from system.

2.5.4 Flexible Pipe Connectors

Provide flexible bronze or stainless steel piping connectors with single braid. Equip flanged assemblies with limit bolts to restrict maximum travel to the manufacturer's standard limits. Unless otherwise indicated, the length of the flexible connectors shall be as recommended by the manufacturer for the service intended. Internal sleeves or liners, compatible with circulating medium, shall be provided when recommended by the manufacturer. Provide covers to protect the bellows where indicated.

2.5.5 Pressure and Vacuum Gauges

Gauges, ASME B40.100 with throttling type needle valve or a pulsation dampener and shut-off valve. Provide gauges with 4.5 inch dial, brass or aluminum case, bronze tube, and siphon. Gauge shall have a range from 0 psig to approximately 1.5 times the maximum system working pressure. Each gauge range shall be selected so that at normal operating pressure, the needle is within the middle-third of the range.

2.5.6 Temperature Gauges

Temperature gauges, shall be the industrial duty type and be provided for the required temperature range. Provide gauges with fixed thread connection, dial face gasketed within the case; and an accuracy within 2 percent of scale range. Gauges shall have Fahrenheit scale in 2 degree graduations scale (black numbers) on a white face. The pointer shall be adjustable. Rigid stem type temperature gauges shall be provided in thermal wells located within 5 feet of the finished floor. Universal adjustable angle type or remote element type temperature gauges shall be provided in thermal wells located 5 to 7 feet above the finished floor or in locations indicated. Remote element type temperature gauges shall be provided in thermal wells located 7 feet above the finished floor or in locations indicated.

2.5.6.1 Stem Cased-Glass

Stem cased-glass case shall be polished stainless steel or cast aluminum, 9 inches long, with clear acrylic lens, and non-mercury filled glass tube with indicating-fluid column.

2.5.6.2 Bimetallic Dial

Bimetallic dial type case shall be not less than 3-1/2 inches, stainless steel, and shall be hermetically sealed with clear acrylic lens. Bimetallic element shall be silicone dampened and unit fitted with external calibrator adjustment.

2.5.6.3 Liquid-, Solid-, and Vapor-Filled Dial

Liquid-, solid-, and vapor-filled dial type cases shall be not less than 3-1/2 inches, stainless steel or cast aluminum with clear acrylic lens. Fill shall be nonmercury, suitable for encountered cross-ambients, and connecting capillary tubing shall be double-braided bronze.

2.5.6.4 Thermal Well

Thermal well shall be identical size, 1/2 or 3/4 inch NPT connection, brass or stainless steel. Where test wells are indicated, provide captive

plug-fitted type 1/2 inch NPT connection suitable for use with either engraved stem or standard separable socket thermometer or thermostat. Mercury shall not be used in thermometers. Extended neck thermal wells shall be of sufficient length to clear insulation thickness by 1 inch.

2.5.7 Pipe Hangers, Inserts, and Supports

Pipe hangers, inserts, guides, and supports: to MSS SP-58 and MSS SP-69. If ferrous materials are utilized provide hot-dipped galvanized hangers, inserts and supports.

2.5.8 Escutcheons

Provide one piece or split hinge metal plates for piping entering floors, walls, and ceilings in exposed spaces. Secure plates in place by internal spring tension or set screws. Provide polished stainless steel plates or chromium-plated finish on copper alloy plates in finished spaces. Provide paint finish on metal plates in unfinished spaces.

2.5.9 Expansion Joints

2.5.9.1 Slip-Tube Type

Slip-tube expansion joints, ASTM F1007, Class I or II. Joints shall be provided with internally-externally alignment guides, injected semi-plastic packing, and service outlets. End connections shall be flanged or beveled for welding as indicated. Initial settings shall be made in accordance with the manufacturer's recommendations to compensate for ambient temperature at time of installation. Pipe alignment guides shall be installed as recommended by the joint manufacturer.

2.5.9.2 Flexible Ball Type

Flexible ball expansion joints shall be capable of 360 degrees rotation plus 15 degrees angular flex movement. Joints shall be constructed of carbon steel with the exterior spherical surface of carbon steel balls plated with a minimum 5 mils of hard chrome in accordance with EJMA Stds. Joint end connections shall be threaded for piping 2 inches or smaller. Joint end connections larger than 2 inches shall be grooved, flanged, or beveled for welding. Provide joint with pressure-molded composition gaskets suitable for continuous operation at twice design temperature.

2.5.9.3 Bellows Type

Bellows expansion type joints, ASTM F1120 with Type 304 stainless steel corrugated bellows, reinforced with equalizing rings, internal sleeves, and external protective covers. Joint end connections shall be grooved, flanged, or beveled for welding. Guiding of piping on both sides of expansion joint shall be in accordance with the published recommendations of the manufacturer of the expansion joint.

2.6 EXPANSION TANKS

Tank shall be welded steel, constructed for, and tested to pressure-temperature rating of 125 psi at 150 degrees F. Provide tanks precharged to the minimum operating pressure. Tank shall have a replaceable polypropylene or butyl lined diaphragm which keeps the air charge separated from the water; shall be the captive air type.

Tanks shall accommodate expanded water of the system generated within the normal operating temperature range, limiting this pressure increase at all components in the system to the maximum allowable pressure at those components. Each tank air chamber shall be fitted with a drain, fill, an air charging valve, and system connections. Tank shall be supported by steel legs or bases for vertical installation or steel saddles for horizontal installations. The only air in the system shall be the permanent sealed-in air cushion contained within the expansion tank.

2.7 AIR SEPARATOR TANKS

External air separation tank shall have an internal design constructed of stainless steel and suitable for creating the required vortex and subsequent air separation. Tank shall be steel, constructed for, and tested to pressure-temperature rating of 125 psi at 150 degrees F. Tank shall have tangential inlets and outlets connections, threaded for 2 inches and smaller and flanged for sizes 2-1/2 inches and larger. Air released from a tank shall be vented as indicated. Tank shall be provided with a blow-down connection.

2.8 ELECTRICAL WORK

Provide motors, controllers, integral disconnects, contactors, and controls with their respective pieces of equipment, except controllers indicated as part of motor control centers. Provide electrical equipment, including motors and wiring, as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Manual or automatic control and protective or signal devices required for the operation specified and control wiring required for controls and devices specified, but not shown, shall be provided. For packaged equipment, the manufacturer shall provide controllers including the required monitors and timed restart.

Provide high efficiency type, single-phase, fractional-horsepower alternating-current motors, including motors that are part of a system, in accordance with NEMA MG 11.

Provide polyphase, squirrel-cage medium induction motors, including motors that are part of a system, that meet the efficiency ratings for premium efficiency motors in accordance with NEMA MG 1. Provide motors in accordance with NEMA MG 1 and of sufficient size to drive the load at the specified capacity without exceeding the nameplate rating of the motor.

Motors shall be rated for continuous duty with the enclosure specified. Motor duty requirements shall allow for maximum frequency start-stop operation and minimum encountered interval between start and stop. Motor torque shall be capable of accelerating the connected load within 20 seconds with 80 percent of the rated voltage maintained at motor terminals during one starting period. Provide motor starters complete with thermal overload protection and other necessary appurtenances. Motor bearings shall be fitted with grease supply fittings and grease relief to outside of the enclosure.

Provide variable frequency drives for motors as specified in Section 26 29 23 VARIABLE FREQUENCY DRIVE SYSTEMS UNDER 600 VOLTS.

2.9 PAINTING OF NEW EQUIPMENT

New equipment painting shall be factory applied or shop applied, and shall be as specified herein, and provided under each individual section.

2.9.1 Factory Painting Systems

Manufacturer's standard factory painting systems may be provided. The factory painting system applied will withstand 125 hours in a salt-spray fog test, except that equipment located outdoors shall withstand 500 hours in a salt-spray fog test.

Salt-spray fog test shall be in accordance with ASTM B117, and for that test, the acceptance criteria shall be as follows: immediately after completion of the test, the paint shall show no signs of blistering, wrinkling, or cracking, and no loss of 0.125 inch on either side of the scratch mark. The film thickness of the factory painting system applied on the equipment shall not be less than the film thickness used on the test specimen.

If manufacturer's standard factory painting system is being proposed for use on surfaces subject to temperatures above 120 degrees F, the factory painting system shall be designed for the temperature service.

2.9.2 Shop Painting Systems for Metal Surfaces

Clean, retreat, prime and paint metal surfaces; except aluminum surfaces need not be painted. Apply coatings to clean dry surfaces. Clean the surfaces to remove dust, dirt, rust, oil and grease by wire brushing and solvent degreasing prior to application of paint, except metal surfaces subject to temperatures in excess of 120 degrees F shall be cleaned to bare metal.

Where hot-dip galvanized steel has been cut, resulting surfaces with no galvanizing shall be coated with a zinc-rich coating conforming to ASTM D520, Type I.

Where more than one coat of paint is specified, apply the second coat after the preceding coat is thoroughly dry. Lightly sand damaged painting and retouch before applying the succeeding coat. Color of finish coat shall be aluminum or light gray.

a. Temperatures Less Than 120 Degrees F: Immediately after cleaning, the metal surfaces subject to temperatures less than 120 degrees F shall receive one coat of pretreatment primer applied to a minimum dry film thickness of 0.3 mil, one coat of primer applied to a minimum dry film thickness of one mil; and two coats of enamel applied to a minimum dry film thickness of one mil per coat.

b. Temperatures Between 120 and 400 degrees F: Metal surfaces subject to temperatures between 120 and 400 degrees F shall receive two coats of 400 degrees F heat-resisting enamel applied to a total minimum thickness of 2 mils.

c. Temperatures Greater Than 400 degrees F: Metal surfaces subject to temperatures greater than 400 degrees F shall receive two coats of 600 degrees F heat-resisting paint applied to a total minimum dry film thickness of 2 mils.

2.10 FACTORY APPLIED INSULATION

Factory insulated items installed outdoors are not required to be fire-rated. As a minimum, factory insulated items installed indoors shall

have a flame spread index no higher than 25 and a smoke developed index no higher than 150. Factory insulated items (no jacket) installed indoors and which are located in air plenums, in ceiling spaces, and in attic spaces shall have a flame spread index no higher than 25 and a smoke developed index no higher than 50. Flame spread and smoke developed indexes shall be determined by ASTM E84.

Insulation shall be tested in the same density and installed thickness as the material to be used in the actual construction. Material supplied by a manufacturer with a jacket shall be tested as a composite material. Jackets, facings, and adhesives shall have a flame spread index no higher than 25 and a smoke developed index no higher than 50 when tested in accordance with ASTM E84.

2.11 NAMEPLATES

Major equipment including pumps, pump motors, expansion tanks, and air separator tanks shall have the manufacturer's name, type or style, model or serial number on a plate secured to the item of equipment. The nameplate of the distributing agent will not be acceptable. Plates shall be durable and legible throughout equipment life and made of stainless steel. Plates shall be fixed in prominent locations with nonferrous screws or bolts.

2.12 RELATED COMPONENTS/SERVICES

2.12.1 Drain and Make-Up Water Piping

Requirements for drain and make-up water piping and backflow preventer is specified in Section 22 00 00 PLUMBING, GENERAL PURPOSE.

2.12.2 Field Applied Insulation

Requirements for field applied insulation is specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.12.3 Field Applied Insulation

Requirements for field installed insulation is specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS, except as supplemented and modified by this specification section.

2.12.4 Field Painting

Requirements for painting of surfaces not otherwise specified, and finish painting of items only primed at the factory, are specified in Section 09 90 00PAINTS AND COATINGS.

2.12.4.1 Color Coding

Requirements for color coding for piping identification are specified in Section 09 90 00 PAINTS AND COATINGS.

PART 3 EXECUTION

3.1 INSTALLATION

Cut pipe accurately to measurements established at the jobsite, and work into place without springing or forcing, completely clearing all windows,

doors, and other openings. Cutting or other weakening of the building structure to facilitate piping installation is not permitted without written approval. Cut pipe or tubing square, remove burrs by reaming, and fashion to permit free expansion and contraction without causing damage to the building structure, pipe, joints, or hangers.

Notify the Contracting Officer in writing at least 15 calendar days prior to the date the connections are required. Obtain approval before interrupting service. Furnish materials required to make connections into existing systems and perform excavating, backfilling, compacting, and other incidental labor as required. Furnish labor and tools for making actual connections to existing systems.

3.1.1 Welding

Provide welding work specified this section for piping systems in conformance with ASME B31.9, as modified and supplemented by this specification section and the accompanying drawings. The welding work includes: qualification of welding procedures, welders, welding operators, brazers, brazing operators, and nondestructive examination personnel; maintenance of welding records, and examination methods for welds.

3.1.1.1 Employer's Record Documents (For Welding)

Submit for review and approval the following documentation. This documentation and the subject qualifications shall be in compliance with ASME B31.9.

a. List of qualified welding procedures that is proposed to be used to provide the work specified in this specification section.

b. List of qualified welders, brazers, welding operators, and brazing operators that are proposed to be used to provide the work specified in this specification section.

c. List of qualified weld examination personnel that are proposed to be used to provide the work specified in this specification section.

3.1.1.2 Welding Procedures and Qualifications

a. Specifications and Test Results: Submit copies of the welding procedures specifications and procedure qualification test results for each type of welding required. Approval of any procedure does not relieve the Contractor of the responsibility for producing acceptable welds. Submit this information on the forms printed in ASME BPVC SEC IX or their equivalent.

b. Certification: Before assigning welders or welding operators to the work, submit a list of qualified welders, together with data and certification that each individual is performance qualified as specified. Do not start welding work prior to submitting welder, and welding operator qualifications. The certification shall state the type of welding and positions for which each is qualified, the code and procedure under which each is qualified, date qualified, and the firm and individual certifying the qualification tests.

3.1.1.3 Examination of Piping Welds

Conduct non-destructive examinations (NDE) on piping welds and brazing and

verify the work meets the acceptance criteria specified in ASME B31.9. NDE on piping welds covered by ASME B31.9 is visual inspection only. Submit a piping welds NDE report meeting the requirements specified in ASME B31.9.

3.1.1.4 Welding Safety

Welding and cutting safety requirements shall be in accordance with AWS Z49.1.

3.1.2 Directional Changes

Make changes in direction with fittings, except that bending of pipe 4 inches and smaller is permitted, provided a pipe bender is used and wide weep bends are formed. Mitering or notching pipe or other similar construction to form elbows or tees is not permitted. The centerline radius of bends shall not be less than 6 diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations is not acceptable.

3.1.3 Functional Requirements

Pitch horizontal supply mains down in the direction of flow as indicated. The grade shall not be less than 1 inch in 40 feet. Reducing fittings shall be used for changes in pipe sizes. Cap or plug open ends of pipelines and equipment during installation to keep dirt or other foreign materials out of the system.

Pipe not otherwise specified shall be uncoated. Connections to appliances shall be made with malleable iron unions for steel pipe 2-1/2 inches or less in diameter, and with flanges for pipe 3 inches and above in diameter. Connections between ferrous and copper piping shall be electrically isolated from each other with dielectric waterways or flanges.

Piping located in air plenums shall conform to NFPA 90A requirements. Pipe and fittings installed in inaccessible conduits or trenches under concrete floor slabs shall be welded. Equipment and piping arrangements shall fit into space allotted and allow adequate acceptable clearances for installation, replacement, entry, servicing, and maintenance. Electric isolation fittings shall be provided between dissimilar metals.

3.1.4 Fittings and End Connections

3.1.4.1 Threaded Connections

Threaded connections shall be made with tapered threads and made tight with PTFE tape complying with ASTM D3308 or equivalent thread-joint compound applied to the male threads only. Not more than three threads shall show after the joint is made.

3.1.4.2 Brazed Connections

Brazing, AWS BRH, except as modified herein. During brazing, the pipe and fittings shall be filled with a pressure regulated inert gas, such as nitrogen, to prevent the formation of scale. Before brazing copper joints, both the outside of the tube and the inside of the fitting shall be cleaned with a wire fitting brush until the entire joint surface is bright and clean. Do not use brazing flux. Surplus brazing material shall be removed at all joints. Steel tubing joints shall be made in

accordance with the manufacturer's recommendations. Piping shall be supported prior to brazing and not be sprung or forced.

3.1.4.3 Welded Connections

Branch connections shall be made with welding tees or forged welding branch outlets. Pipe shall be thoroughly cleaned of all scale and foreign matter before the piping is assembled. During welding, the pipe and fittings shall be filled with an inert gas, such as nitrogen, to prevent the formation of scale. Beveling, alignment, heat treatment, and inspection of weld shall conform to ASME B31.9. Weld defects shall be removed and rewelded at no additional cost to the Government. Electrodes shall be stored and dried in accordance with AWS D1.1/D1.1M or as recommended by the manufacturer. Electrodes that have been wetted or that have lost any of their coating shall not be used.

3.1.4.4 Flared Connections

When flared connections are used, a suitable lubricant shall be used between the back of the flare and the nut in order to avoid tearing the flare while tightening the nut.

3.1.4.5 Flanges and Unions

Except where copper tubing is used, union or flanged joints shall be provided in each line immediately preceding the connection to each piece of equipment or material requiring maintenance such as coils, pumps, control valves, and other similar items. Flanged joints shall be assembled square end tight with matched flanges, gaskets, and bolts. Gaskets shall be suitable for the intended application.

3.1.5 Valves

Isolation gate or ball valves shall be installed on each side of each piece of equipment, at the midpoint of all looped mains, and at any other points indicated or required for draining, isolating, or sectionalizing purpose. Isolation valves may be omitted where balancing cocks are installed to provide both balancing and isolation functions. Each valve except check valves shall be identified. Valves in horizontal lines shall be installed with stems horizontal or above.

3.1.6 Air Vents

Air vents shall be provided at all high points, on all water coils, and where indicated to ensure adequate venting of the piping system.

3.1.7 Drains

Drains shall be provided at all low points and where indicated to ensure complete drainage of the piping. Drains shall be accessible, and shall consist of nipples and caps or plugged tees unless otherwise indicated.

3.1.8 Flexible Pipe Connectors

Connectors shall be attached to components in strict accordance with the latest printed instructions of the manufacturer to ensure a vapor tight joint. Hangers, when required to suspend the connectors, shall be of the type recommended by the flexible pipe connector manufacturer and shall be provided at the intervals recommended.

3.1.9 Temperature Gauges

Temperature gauges shall be located on coolant supply and return piping at each heat exchanger, on condenser water piping entering and leaving a condenser, at each automatic temperature control device without an integral thermometer, and where indicated or required for proper operation of equipment. Thermal wells for insertion thermometers and thermostats shall extend beyond thermal insulation surface not less than 1 inch.

3.1.10 Pipe Hangers, Inserts, and Supports

Pipe hangers, inserts, and supports shall conform to MSS SP-58 and MSS SP-69, except as supplemented and modified in this specification section. Pipe hanger types 5, 12, and 26 shall not be used. Hangers used to support piping 2 inches and larger shall be fabricated to permit adequate adjustment after erection while still supporting the load. Piping subjected to vertical movement, when operating temperatures exceed ambient temperatures, shall be supported by variable spring hangers and supports or by constant support hangers.

3.1.10.1 Hangers

Type 3 shall not be used on insulated piping. Type 24 may be used only on trapeze hanger systems or on fabricated frames.

3.1.10.2 Inserts

Type 18 inserts shall be secured to concrete forms before concrete is placed. Continuous inserts which allow more adjustments may be used if they otherwise meet the requirements for Type 18 inserts.

3.1.10.3 C-Clamps

Type 19 and 23 C-clamps shall be torqued per MSS SP-69 and have both locknuts and retaining devices, furnished by the manufacturer. Field-fabricated C-clamp bodies or retaining devices are not acceptable.

3.1.10.4 Angle Attachments

Type 20 attachments used on angles and channels shall be furnished with an added malleable-iron heel plate or adapter.

3.1.10.5 Saddles and Shields

Where Type 39 saddle or Type 40 shield are permitted for a particular pipe attachment application, the Type 39 saddle, connected to the pipe, shall be used on all pipe 4 inches and larger when the temperature of the medium is 60 degrees F or higher. Type 40 shields shall be used on all piping less than 4 inches and all piping 4 inches and larger carrying medium less than 60 degrees F. A high density insulation insert of cellular glass shall be used under the Type 40 shield for piping 2 inches and larger.

3.1.10.6 Horizontal Pipe Supports

Horizontal pipe supports shall be spaced as specified in MSS SP-69 and a support shall be installed not over 1 foot from the pipe fitting joint at each change in direction of the piping. Pipe supports shall be spaced not over 5 feet apart at valves. Pipe hanger loads suspended from steel joist

with hanger loads between panel points in excess of 50 pounds shall have the excess hanger loads suspended from panel points.

3.1.10.7 Vertical Pipe Supports

Vertical pipe shall be supported at each floor, except at slab-on-grade, and at intervals of not more than 15 feet, not more than 8 feet from end of risers, and at vent terminations.

3.1.10.8 Pipe Guides

Type 35 guides using, steel, reinforced polytetrafluoroethylene (PTFE) or graphite slides shall be provided where required to allow longitudinal pipe movement. Lateral restraints shall be provided as required. Slide materials shall be suitable for the system operating temperatures, atmospheric conditions, and bearing loads encountered.

3.1.10.9 Steel Slides

Where steel slides do not require provisions for restraint of lateral movement, an alternate guide method may be used. On piping 4 inches and larger, a Type 39 saddle shall be used. On piping under 4 inches, a Type 40 protection shield may be attached to the pipe or insulation and freely rest on a steel slide plate.

3.1.10.10 Multiple Pipe Runs

In the support of multiple pipe runs on a common base member, a clip or clamp shall be used where each pipe crosses the base support member. Spacing of the base support members shall not exceed the hanger and support spacing required for an individual pipe in the multiple pipe run.

3.1.10.11 Structural Attachments

Attachment to building structure concrete and masonry shall be by cast-in concrete inserts, built-in anchors, or masonry anchor devices. Inserts and anchors shall be applied with a safety factor not less than 5. Supports shall not be attached to metal decking. Supports shall not be attached to the underside of concrete filled floors or concrete roof decks unless approved by the Contracting Officer. Masonry anchors for overhead applications shall be constructed of ferrous materials only. Structural steel brackets required to support piping, headers, and equipment, but not shown, shall be provided under this section. Material used for support shall be as specified under Section 05 12 00 STRUCTURAL STEEL.

3.1.11 Pipe Alignment Guides

Pipe alignment guides shall be provided where indicated for expansion loops, offsets, and bends and as recommended by the manufacturer for expansion joints, not to exceed 5 feet on each side of each expansion joint, and in lines 4 inches or smaller not more than 2 feet on each side of the joint.

3.1.12 Pipe Anchors

Anchors shall be provided where indicated. Unless indicated otherwise, anchors shall comply with the requirements specified. Anchors shall consist of heavy steel collars with lugs and bolts for clamping and attaching anchor braces, unless otherwise indicated. Anchor braces shall

be installed in the most effective manner to secure the desired results using turnbuckles where required.

Supports, anchors, or stays shall not be attached where they will injure the structure or adjacent construction during installation or by the weight of expansion of the pipeline. Where pipe and conduit penetrations of vapor barrier sealed surfaces occur, these items shall be anchored immediately adjacent to each penetrated surface, to provide essentially zero movement within penetration seal.

3.1.13 Building Surface Penetrations

Sleeves shall not be installed in structural members except where indicated or approved. Except as indicated otherwise piping sleeves shall comply with requirements specified. Sleeves in nonload bearing surfaces shall be galvanized sheet metal, conforming to ASTM A653/A653M, Coating Class G-90, 20 gauge. Sleeves in load bearing surfaces shall be uncoated carbon steel pipe, conforming to ASTM A53/A53M, Schedule 30 Standard weight. Sealants shall be applied to moisture and oil-free surfaces and elastomers to not less than 1/2 inch depth. Sleeves shall not be installed in structural members.

3.1.13.1 Refrigerated Space

Refrigerated space building surface penetrations shall be fitted with sleeves fabricated from hand-lay-up or helically wound, fibrous glass reinforced polyester or epoxy resin with a minimum thickness equal to equivalent size Schedule 40 steel pipe. Sleeves shall be constructed with integral collar or cold side shall be fitted with a bonded slip-on flange or extended collar.

In the case of masonry penetrations where sleeve is not cast-in, voids shall be filled with latex mixed mortar cast to shape of sleeve and flange/external collar type sleeve shall be assembled with butyl elastomer vapor barrier sealant through penetration to cold side surface vapor barrier overlap and fastened to surface with masonry anchors.

Integral cast-in collar type sleeve shall be flashed with not less than 4 inches of cold side vapor barrier overlap of sleeve surface. Normally noninsulated penetrating round surfaces shall be sealed to sleeve bore with mechanically expandable seals in vapor tight manner and remaining warm and cold side sleeve depth shall be insulated with not less than 4 inches of foamed-in-place rigid polyurethane or foamed-in-place silicone elastomer.

Vapor barrier sealant shall be applied to finish warm side insulation surface. Warm side of penetrating surface shall be insulated beyond vapor barrier sealed sleeve insulation for a distance which prevents condensation. Wires in refrigerated space surface penetrating conduit shall be sealed with vapor barrier plugs or compound to prevent moisture migration through conduit and condensation therein.

3.1.13.2 General Service Areas

Each sleeve shall extend through its respective wall, floor, or roof, and shall be cut flush with each surface. Pipes passing through concrete or masonry wall or concrete floors or roofs shall be provided with pipe sleeves fitted into place at the time of construction. Sleeves shall be of such size as to provide a minimum of 1/4 inch all-around clearance

between bare pipe and sleeves or between jacketed-insulation and sleeves. Except in pipe chases or interior walls, the annular space between pipe and sleeve or between jacket over-insulation and sleeve shall be sealed in accordance with Section 07 92 00 JOINT SEALANTS.

3.1.13.3 Waterproof Penetrations

Pipes passing through roof or floor waterproofing membrane shall be installed through a .17 ounce copper sleeve, or a 0.032 inch thick aluminum sleeve, each within an integral skirt or flange.

Flashing sleeve shall be suitably formed, and skirt or flange shall extend not less than 8 inches from the pipe and be set over the roof or floor membrane in a troweled coating of bituminous cement. The flashing sleeve shall extend up the pipe a minimum of 2 inches above the roof or floor penetration. The annular space between the flashing sleeve and the bare pipe or between the flashing sleeve and the metal-jacket-covered insulation shall be sealed as indicated. Penetrations shall be sealed by either one of the following methods.

a. Waterproofing Clamping Flange: Pipes up to and including 10 inches in diameter passing through roof or floor waterproofing membrane may be installed through a cast iron sleeve with caulking recess, anchor lugs, flashing clamp device, and pressure ring with brass bolts. Waterproofing membrane shall be clamped into place and sealant shall be placed in the caulking recess.

b. Modular Mechanical Type Sealing Assembly: In lieu of a waterproofing clamping flange, a modular mechanical type sealing assembly may be installed. Seals shall consist of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe/conduit and sleeve with corrosion protected carbon steel bolts, nuts, and pressure plates. Links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and each nut.

   After the seal assembly is properly positioned in the sleeve, tightening of the bolt shall cause the rubber sealing elements to expand and provide a watertight seal rubber sealing elements to expand and provide a watertight seal between the pipe/conduit seal between the pipe/conduit and the sleeve. Each seal assembly shall be sized as recommended by the manufacturer to fit the pipe/conduit and sleeve involved. The Contractor electing to use the modular mechanical type seals shall provide sleeves of the proper diameters.

3.1.13.4 Fire-Rated Penetrations

Penetration of fire-rated walls, partitions, and floors shall be sealed as specified in Section 07 84 00 FIRESTOPPING.

3.1.13.5 Escutcheons

Finished surfaces where exposed piping, bare or insulated, pass through floors, walls, or ceilings, except in boiler, utility, or equipment rooms, shall be provided with escutcheons. Where sleeves project slightly from floors, special deep-type escutcheons shall be used. Escutcheon shall be secured to pipe or pipe covering.

3.1.14 Access Panels

Access panels shall be provided where indicated for all concealed valves, vents, controls, and additionally for items requiring inspection or maintenance. Access panels shall be of sufficient size and located so that the concealed items may be serviced and maintained or completely removed and replaced. Access panels shall be as specified in Section 05 50 13 MISCELLANEOUS METAL FABRICATIONS.

3.2 ELECTRICAL INSTALLATION

Install electrical equipment in accordance with NFPA 70 and manufacturers instructions.

3.3 CLEANING AND ADJUSTING

Pipes shall be cleaned free of scale and thoroughly flushed of all foreign matter. A temporary bypass shall be provided for all water coils to prevent flushing water from passing through coils. Strainers and valves shall be thoroughly cleaned. Prior to testing and balancing, air shall be removed from all water systems by operating the air vents. Temporary measures, such as piping the overflow from vents to a collecting vessel shall be taken to avoid water damage during the venting process. Air vents shall be plugged or capped after the system has been vented. Control valves and other miscellaneous equipment requiring adjustment shall be adjusted to setting indicated or directed.

3.4 FIELD TESTS

Field tests shall be conducted in the presence of the QC Manager or his designated representative to verify systems compliance with specifications. Any material, equipment, instruments, and personnel required for the test shall be provided by the Contractor.

3.4.1 Equipment and Component Isolation

Prior to testing, equipment and components that cannot withstand the tests shall be properly isolated.

3.4.2 Pressure Tests

Each piping system , except for polypropylene piping, shall be hydrostatically tested at a pressure not less than 188 psig for period of time sufficient to inspect every joint in the system and in no case less than 2 hours. Test pressure shall be monitored by a currently calibrated test pressure gauge. Leaks shall be repaired and piping retested until test requirements are met. No leakage or reduction in gage pressure shall be allowed.

Leaks shall be repaired by rewelding or replacing pipe or fittings. Caulking of joints will not be permitted. Concealed and insulated piping shall be tested in place before concealing.

Submit for approval pressure tests reports covering the above specified piping pressure tests; describe the systems tested, test results, defects found and repaired, and signature of the pressure tests' director. Obtain approval from the QC Manager before concealing piping or applying insulation to tested and accepted piping.

3.4.3 Related Field Inspections and Testing

3.4.3.1 Piping Welds

Examination of Piping Welds is specified in the paragraph EXAMINATION OF PIPING WELDS (above).

3.4.3.2 HVAC TAB

Requirements for testing, adjusting, and balancing (TAB) of HVAC water piping, and associated equipment is specified in Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC. Coordinate with the TAB team, and provide support personnel and equipment as specified in Section 23 05 93 TESTING, ADJUSTING AND BALANCING FOR HVAC to assist TAB team to meet the TAB work requirements.

3.5 INSTRUCTION TO GOVERNMENT PERSONNEL

Furnish the services of competent instructors to give full instruction to the designated Government personnel in the adjustment, operation, and maintenance, including pertinent safety requirements, of the chilled water systems. Instructors shall be thoroughly familiar with all parts of the installation and shall be instructed in operating theory as well as practical operation and maintenance work. Submit a lesson plan for the instruction course for approval. The lesson plan and instruction course shall be based on the approved operation and maintenance data and maintenance manuals.

Conduct a training course for the operating staff and maintenance staff selected by the Contracting Officer. Give the instruction during the first regular work week after the equipment or system has been accepted and turned over to the Government for regular operation. The number of man-days (8 hours per day) of instruction furnished shall be one man-day. Use approximately half of the time for classroom instruction and the other time for instruction at the location of equipment or system.

When significant changes or modifications in the equipment or system are made under the terms of the contract, provide additional instruction to acquaint the operating personnel with the changes or modifications.

-- End of Section --

SECTION 25 10 10

UTILITY MONITORING AND CONTROL SYSTEM (UMCS) FRONT END AND INTEGRATION
02/19

PART 1 GENERAL

1.1 SUMMARY

Provide integration of the building control systems installed per Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS to the Utility Monitoring and Control System (UMCS) via a Niagara Framework Supervisory Gateway as specified. The Supervisory Gateway must be a JACE-8XXX (or other approved model) that is compatible with the current version (v4.7 or later) of Niagara N4 installed in Building B2101.

The UMCS must perform supervisory monitoring and supervisory control of building control systems and utility control systems using one or more of: CEA-709.1-D (LonWorks) with LonWorks Network Services (LNS), or the Niagara Framework with Fox protocol as indicated and shown.

1.1.1 System Requirements

Provide a UMCS as specified and indicated, and in accordance with the following characteristics:

1.1.1.1 General System Requirements

a. The system performs supervisory monitoring and control functions including but not limited to Scheduling, Alarm Handling, Trending, Overrides, Report Generation, and Electrical Demand Limiting as specified.

b. The system includes a Graphical User Interface which allows for graphical navigation between systems, graphical representations of systems, access to real-time data for systems, ability to override points in a system, and access to all supervisory monitoring and control functions.

c. All software used by the UMCS and all software used to install and configure the UMCS is licensed to and delivered to the installation.

d. All necessary documentation, configuration information, configuration tools, programs, drivers, and other software is licensed to and otherwise remains with the Government such that the Government or their agents are able to repair, replace, upgrade, and expand the system without subsequent or future dependence on the Contractor. Software licenses must not require periodic fees and must be valid in perpetuity.

e. Provide sufficient documentation and data, including rights to documentation and data, such that the Government or their agents can execute work to repair, replace, upgrade, and expand the system without subsequent or future dependence on the Contractor.

f. The UMCS interfaces directly to ASHRAE 135, CEA-709.1-D, MODBUS Protocol, MODBUS TCP/IP, OPC DA, and Niagara Framework field control systems as specified and may interface to field control systems using other protocols via an M&C Software protocol driver or a Gateway.

g. For UMCS systems with Monitoring and Control Software functionality implemented in Monitoring and Control (M&C) Controller Hardware, provide sufficient additional controller hardware to support the full capacity requirements as specified.

h. All Niagara Framework components have an unrestricted interoperability license with a Niagara Compatibility Statement (NiCS) following the Tridium Open NiCS Specification and have a value of "ALL" for "Station Compatibility In", "Station Compatibility Out", "Tool Compatibility In" and "Tool Compatibility Out". Note that this will result in the following entries in the license.dat file:
   accept.station.in="*"
   accept.station.out="*"
   accept.wb.in="*"
   accept.wb.out="*"

i. The version of Niagara Framework used on this project must be Version 4.0 or later.

1.1.1.2 Niagara Framework Requirements

The UMCS must use the Niagara Framework and must communicate with Niagara Framework field control systems using the Fox protocol and HTTP over the Government furnished IP network as indicated and specified.

1.1.2 General Cybersecurity Requirements

Address cybersecurity in accordance with DA AR 25-2 and Specification Sections 25 05 11.21 and 25 05 11.23.

1.1.3 Symbols, Definition and Abbreviations

Use symbols, definitions, and engineering unit abbreviations indicated in the contract drawings for displays, submittals and reports. For symbols, definitions and abbreviations not in the contract drawings use terms conforming at a minimum to IEEE Stds Dictionary and the ASHRAE FUN IP, as applicable.

1.1.4 System Units and Accuracy

Use English (inch-pound) units for displays, print-outs and calculations. Perform calculations with an accuracy of at least three significant figures. For displays and printouts present values to at least three significant figures.

1.1.5 Data Packages/Submittals Requirements

Technical data packages consisting of computer software and technical data (meaning technical data which relates to computer software) which are specifically identified in this project and which may be defined/required in other specifications must be delivered strictly in accordance with the CONTRACT CLAUSES and in accordance with the Contract Data Requirements List, DD Form 1423. Data delivered must be identified by reference to the

particular specification paragraph against which it is furnished. All submittals not specified as technical data packages are considered shop drawings under the Federal Acquisition Regulation Supplement (FARS) and must contain no proprietary information and must be delivered with unrestricted rights.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI INCITS 154	(1988; R 2004) Office Machines and Supplies - Alphanumeric Machines - Keyboard Arrangement

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 135	(2016) BACnet—A Data Communication Protocol for Building Automation and Control Networks
ASHRAE FUN IP	(2017) Fundamentals Handbook, I-P Edition

CONSUMER ELECTRONICS ASSOCIATION (CEA)

CEA-709.1-D	(2014) Control Network Protocol Specification
CEA-709.3	(1999; R 2015) Free-Topology Twisted-Pair Channel Specification
CEA-852-C	(2014) Tunneling Device Area Network Protocols Over Internet Protocol Channels

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 802.11	(2016; AI 2017; AJ 2018; AK 2018; AQ 2018) Information Technology-Telecommunications and Information Exchange Between Systems Local and Metropolitan Area Networks-Specific Requirements Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications
IEEE C62.41	(1991; R 1995) Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits
IEEE Stds Dictionary	(2009) IEEE Standards Dictionary: Glossary of Terms & Definitions

INTERNET ENGINEERING TASK FORCE (IETF)

IETF RFC 4361	(2006) Node-specific Client Identifiers for Dynamic Host Configuration Protocol

	Version Four (DHCPv4)
IETF RFC 7465	(2015) Prohibiting RC4 Cipher Suites
RFC 821	(2001) Simple Mail Transfer Protocol (SMTP)
LONMARK INTERNATIONAL (LonMark)	
LonMark Interoperability Guide	(2005) LonMark Application-Layer Interoperability Guide and LonMark Layer 1-6 Interoperability Guide; Version 3.4
LonMark SNVT List	(2014) LonMark SNVT Master List; Version 15
LonMark XIF Guide	(2001) LonMark External Interface File Reference Guide; Revision 4.402
MODBUS ORGANIZATION, INC (MODBUS)	
MODBUS Protocol	(2012) Modbus Application Protocol Specification; Version 1.1b3
MODBUS TCP/IP	(2006) Modbus Messaging on TCP/IP Implementation Guide; Version V1.0b
NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)	
NEMA 250	(2018) Enclosures for Electrical Equipment (1000 Volts Maximum)
NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)	
NFPA 70	(2020; ERTA 20-1 2020; ERTA 20-2 2020; TIA 20-1; TIA 20-2; TIA 20-3; TIA 20-4) National Electrical Code
NFPA 262	(2019) Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces
OPC FOUNDATION (OPC)	
OPC DA	(Ver 3.0; Errata) OPC Data Access (DA)
TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)	
TIA-568-C.1	(2009; Add 2 2011; Add 1 2012) Commercial Building Telecommunications Cabling Standard
TIA-606	(2017c) Administration Standard for the Telecommunications Infrastructure
TIA-607	(2015c; Addendum 1 2017) Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises

~~TRIDIUM, INC (TRIDIUM)~~

~~Niagara Framework~~	~~(2012) NiagaraAX User's Guide~~
~~Tridium Open NiCS~~	~~Understanding the NiagaraN4 Compatibility Statement (NiCS)~~

U.S. ARMY (DA)

DA AR 25-2	(2007; RAR 2009) Information Assurance

U.S. FEDERAL COMMUNICATIONS COMMISSION (FCC)

FCC EMC	(2002) FCC Electromagnetic Compliance Requirements
FCC Part 15	Radio Frequency Devices (47 CFR 15)

UNDERWRITERS LABORATORIES (UL)

UL 1778	(2014; Reprint Sep 2017) UL Standard for Safety Uninterruptible Power Systems
UL 60950	(2000; Reprint Oct 2007) Safety of Information Technology Equipment

1.3 DEFINITIONS

The following list of definitions may contain terms not found elsewhere in this Section but are included here for completeness. Some terms are followed with a protocol reference in parenthesis indicating to which protocol the term and definition applies. Inclusion of protocol-specific definitions does not create a requirement to support that protocol, nor does it relax any requirements to support specific protocols as indicated elsewhere in this section.

1.3.1 Alarm Generation

The process of comparing a point value (the point being alarmed) with a pre-defined alarm condition (e.g. a High Limit) and performing some action based on the result of the comparison.

1.3.2 Alarm Handling

see Alarm Routing

1.3.3 Alarm Routing

Alarm routing is M&C software functionality that starts with a notification that an alarm exists (typically as the output of an Alarm Generation process) and sends a specific message to a specific alarm recipient or device.

1.3.4 Application Generic Controller (AGC)(LonWorks)

A device that is furnished with a (limited) pre-established application that also has the capability of being programmed. Further, the ProgramID and XIF file of the device are fixed. The programming capability of an AGC may be less flexible than that of a General Purpose Programmable

Controller (GPPC).

1.3.5 Application Specific Controller (ASC)(LonWorks)

A device that is furnished with a pre-established built in application that is configurable but not re-programmable. An ASC has a fixed factory-installed application program (i.e Program ID) with configurable settings.

1.3.6 Binary

A two-state system or signal; for example one where an "ON" condition is represented by a high signal level and an "OFF" condition is represented by a low signal level. 'Digital' is sometimes used interchangeably with 'binary'.

1.3.7 Binding (LonWorks)

The act of establishing communications between CEA-709.1-D devices by associating the output of a device to the input of another so that information is automatically (and regularly) sent without being requested by the recipient.

1.3.8 Broadcast

Unlike most messages, which are intended for a specific recipient device, a broadcast message is intended for all devices on the network.

1.3.9 Building Control Network (BCN)

The network used by the Building Control System. Typically the BCN is a BACnet ASHRAE 135 or LonWorks CEA-709.1-D network installed by the building control system contractor.

1.3.10 Building Control System (BCS)

One type of Field Control System. A control system for building electrical and mechanical systems, typically HVAC (including central plants) and lighting. A BCS generally uses Direct Digital Control (DDC) Hardware and generally does NOT include its own local front end.

1.3.11 Building Point of Connection (BPOC)

A FPOC for a Building Control System. (This term is being phased out of use in preference for FPOC but is still used in some specifications and criteria. When it was used, it typically referred to a piece of control hardware. The current FPOC definition typically refers instead to IT hardware)

1.3.12 Channel (LonWorks)

A portion of the control network consisting of one or more segments connected by repeaters. Channels are separated by routers. The device quantity limitation is dependent on the topology/media and device type. For example, a TP/FT-10 network with locally powered devices is limited to 128 devices per channel.

1.3.13 Configuration Property (LonWorks)

Controller parameter used by the application which is usually set during installation/testing and seldom changed. For example, the P and I settings of a P-I control loop. Also see 'Standard Configuration Property Type (SCPT)'

1.3.14 Control Logic Diagram

A graphical representation of control logic for multiple processes that make up a system.

1.3.15 Explicit Messaging (LonWorks)

A non-standard and often vendor (application) specific method of communication between devices.

1.3.16 External Interface File (XIF) (LonWorks)

A file which documents a device's external interface, specifically the number and types of LonMark objects, the number, types, directions, and connection attributes of network variables, and the number of message tags.

1.3.17 Field Point Of Connection (FPOC)

The FPOC is part of the UMCS IP network and acts as the point of connection between the UMCS IP Network and the field control IP network. The FPOC is an IT device such as a switch, IP router, or firewall, typically managed by the site IT staff. (Note that the field control IP network may consist of a single IP device, or that integration may require installation of a field control network IP device.)

1.3.18 Field Control Network

The network used by a field control system.

1.3.19 Field Control System (FCS)

A building control system or utility control system.

1.3.20 Fox Protocol (Niagara Framework)

The protocol used for communication between components in the Niagara Framework. By default, Fox uses TCP port 1911

1.3.21 Functional Profile (LonWorks)

A standard description, defined by LonMark International, of a LonMark Object used to classify and certify devices.

1.3.22 Gateway

A device that translates from one protocol to another. Devices that change only the transport mechanism of the protocol - "translating" from LonWorks over TP/FT-10 to LonWorks over IP for example - are not gateways as the underlying protocol (data format) does not change. Gateways are also called Communications Bridges or Protocol Translators.

1.3.23 General Purpose Programmable Controller (GPPC) (LonWorks)

Unlike an ASC or AGC, a GPPC is not furnished with a fixed application program and does not have a fixed ProgramID or XIF file. A GPPC can be (re-)programmed, usually using vendor-supplied software. When a change to the program affects the external interface (and the XIF file) the ProgramID will change.

1.3.24 JACE (Niagara Framework)

Java Application Control Engine. See Niagara Framework Supervisory Gateway

1.3.25 LonMark Object (LonWorks)

A collection of network variables, configuration properties, and associated behavior defined by LonMark International and described by a Functional Profile. It defines how information is exchanged between devices on a network (inputs from and outputs to the network).

1.3.26 LNS Plug-in (LonWorks)

Software which runs in an LNS compatible software tool, typically a network configuration tool. Device configuration plug-ins provide a 'user friendly' method to edit a device's configuration properties.

1.3.27 LonMark (LonWorks)

See LonMark International. Also, a certification issued by LonMark International to CEA-709.1-D devices.

1.3.28 LonMark International (LonWorks)

Standards committee consisting of independent product developers, system integrators and end users dedicated to determining and maintaining the interoperability guidelines for LonWorks. Maintains guidelines for the interoperability of CEA-709.1-D devices and issues the LonMark Certification for CEA-709.1-D devices.

1.3.29 LonWorks (LonWorks)

The term used to refer to the overall technology related to the CEA-709.1-D protocol (sometimes called "LonTalk"), including the protocol itself, network management, interoperability guidelines and products.

1.3.30 LonWorks Network Services (LNS) (LonWorks)

A network management and database standard for CEA-709.1-D devices.

1.3.31 LonWorks Network Services (LNS) Database (LonWorks)

The standard database created and used by LonWorks Network Services (LNS) compatible tools, such as LNS Network Configuration tools.

1.3.32 Modbus

A basic protocol for control network communications generally used in utility control systems. The Modbus protocol standard is maintained by The Modbus Organization.

1.3.33 Monitoring and Control (M&C) Software

The UMCS 'front end' software which performs supervisory functions such as alarm handling, scheduling and data logging and provides a user interface for monitoring the system and configuring these functions.

1.3.34 Network (BACnet)

In BACnet, a portion of the control internetwork consisting of one or more segments of the same media connected by repeaters. Networks are separated by routers.

1.3.35 Network Variable (LonWorks)

See 'Standard Network Variable Type (SNVT)'.

1.3.36 Network Configuration Tool (LonWorks)

The software used to configure the control network and set device configuration properties. This software creates and modifies the control network database (LNS Database).

1.3.37 Niagara Framework

A set of hardware and software specifications for building and utility control owned by Tridium Inc. and licensed to multiple vendors. The Framework consists of front end (M&C) software, web based clients, field level control hardware, and engineering tools. While the Niagara Framework is not adopted by a recognized standards body and does not use an open licensing model, it is sufficiently well-supported by multiple HVAC vendors to be considered a de-facto Open Standard.

1.3.38 Niagara Framework Supervisory Gateway (Niagara Framework)

DDC Hardware component of the Niagara Framework. A typical Niagara architecture has Niagara specific supervisory gateways at the IP level and other (non-Niagara specific) controllers on field networks (TP/FT-10, MS/TP, etc.) beneath the Niagara supervisory gateways. The Niagara specific controllers function as a gateway between the Niagara framework protocol (Fox) and the field network beneath. These supervisory gateways may also be used as general purpose controllers and also have the capability to provide a web-browser based user interface.

Note that different vendors refer to this component by different names. The most common name is "JACE"; other names include "EC-BOS", "FX-40", and "UNC".

1.3.39 Node (LonWorks)

A device that communicates using the CEA-709.1-D protocol and is connected to a CEA-709.1-D network.

1.3.40 Node Address (LonWorks)

The logical address of a node on the network, consisting of a Domain number, Subnet number and Node number. Note that the "Node number" portion of the address is the number assigned to the device during installation and is unique within a subnet. This is not the factory-set unique Node ID (see Node ID).

1.3.41 Node ID (LonWorks)

A unique 48-bit identifier assigned (at the factory) to each CEA-709.1-D device. Sometimes called the Neuron ID.

1.3.42 Override

To change the value of a point outside of the normal sequence of operation where this change has priority over the sequence. An override can be accomplished in one of two ways: the point itself may be Commandable and written to with a priority or there may be a separate point on the controller for the express purpose of implementing the override.

Typically this override is from the Utility Monitoring and Control System (UMCS) Monitoring and Control (M&C) Software. Note that this definition is not standard throughout industry.

1.3.43 Point, Calculated

A value within the M&C Software that is not a network point but has been calculated by logic within the software based on the value of network points or other calculated points. Calculated points are sometimes called virtual points or internal points.

1.3.44 Point, Network

A value that the M&C Software reads from or writes to a field control network.

1.3.45 Polling

A requested transmission of data between devices, rather than an unrequested transmission such as Change-Of-Value (COV) or Binding where data is automatically transmitted under certain conditions.

1.3.46 Program ID (LonWorks)

An identifier (number) stored in the device (usually EEPROM) that identifies the node manufacturer, functionality of device (application & sequence), transceiver used, and intended device usage.

1.3.47 Protocol Implementation Conformance Statement (PICS)(BACnet)

A document, created by the manufacturer of a device, which describes which potions of the BACnet standard are implemented by a given device.

1.3.48 Repeater

A device that connects two control network segments and retransmits all information received on one side onto the other.

1.3.49 Router (LonWorks)

A device that connects two channels and controls traffic between the channels by retransmitting signals received from one subnet onto the other based on the signal destination. Routers are used to subdivide a control network and to control bandwidth usage.

1.3.50 Segment

A 'single' section of a control network that contains no repeaters or routers. There is generally a limit on the number of devices on a segment, and this limit is dependent on the topology/media and device type. For example, a TP/FT-10 segment with locally powered devices is limited to 64 devices, and a BACnet MS/TP segment is limited to 32 devices.

1.3.51 Service Pin (LonWorks)

A hardware push-button on a device which causes the device to broadcast a message containing its Node ID and Program ID. This broadcast can also be initiated via software.

1.3.52 Standard Configuration Property Type (SCPT) (LonWorks)

Pronounced 'skip-it'. A standard format type (maintained by LonMark International) for Configuration Properties.

1.3.53 Standard Network Variable Type (SNVT) (LonWorks)

Pronounced 'snivet'. A standard format type (maintained by LonMark International) used to define data information transmitted and received by the individual nodes. The term SNVT is used in two ways. Technically it is the acronym for Standard Network Variable Type, and is sometimes used in this manner. However, it is often used to indicate the network variable itself (i.e. it can mean "a network variable of a standard network variable type"). In general, the intended meaning should be clear from the context.

1.3.54 Subnet (LonWorks)

Consists of a logical grouping of up to 127 nodes, where the logical grouping is defined by node addressing. Each subnet is assigned a number which is unique within the Domain. See also Node Address.

1.3.55 Supervisory Controller

A controller implementing a combination of supervisory logic (global control strategies or optimization strategies), scheduling, alarming, event management, trending, web services or network management. Note this is defined by use; many supervisory controllers have the capability to also directly control equipment.

1.3.56 Supervisory Gateway

A device that is both a supervisory controller and a gateway, such as a Niagara Framework Supervisory Gateway.

1.3.57 TP/FT-10 (LonWorks)

A Free Topology Twisted Pair network (at 78 kbps) defined by CEA-709.3. This is the most common media type for a CEA-709.1-D control network.

1.3.58 TP/XF-1250 (LonWorks)

A high speed (1.25 Mbps) twisted pair, doubly-terminated bus network defined by the LonMark Interoperability Guidelines. This media is typically used only as a backbone media to connect multiple TP/FT-10

networks.

1.3.59 UMCS Network

An IP network connecting multiple field control systems to the Monitoring and Control Software using one or more of: LonWorks (CEA-709.1-D and CEA-852-C), BACnet (ASHRAE 135 Annex J), MODBUS Protocol, MODBUS TCP/IP or OPC DA.

1.3.60 User-defined Configuration Property Type (UCPT) (LonWorks)

Pronounced 'u-keep-it'. A Configuration Property format type that is defined by the device manufacturer.

1.3.61 User-defined Network Variable Type (UNVT) (LonWorks)

A network variable format defined by the device manufacturer. Note that UNVTs create non-standard communications (other vendor's devices may not correctly interpret it) and may close the system and therefore are not permitted by this specification.

1.3.62 Utility Control System (UCS)

One type of field control system. Used for control of utility systems such as an electrical substation, sanitary sewer lift station, water pump station, etc. Building controls are excluded from a UCS, however it is possible to have a Utility Control System and a Building Control System in the same facility, and for those systems to share components such as the FPOC. A UCS may include its own local front-end.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submittals with an "AE" are for submittal to the Designer of Record. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES and TABLE 1: PROJECT SEQUENCING:

SD-02 Shop Drawings

UMCS Contractor Design Drawings; G, RO

UMCS Contractor Design Drawings as a single complete package: 2 hard copies and 2 copies on CDROM. Submit hardcopy drawings on A3 17 by 11 inches sheets, and electronic drawings in both PDF and Autodesk Revit format.

Draft As-Built Drawings; G, RO

Draft As-Built Drawings as a single complete package: 2 hard copies and 2 copies on CDROM. Submit hardcopy drawings must on A3 17 by 11 inches sheets, and electronic drawings in both PDF and Autodesk Revit format.

Final As-Built Drawings; G, RO

Final As-Built Drawings as a single complete package: 2 hard copies and 2 copies on CDROM. Submit hardcopy drawings on A3 17 by 11 inches sheets, and electronic drawings in both PDF and Autodesk Revit format.

SD-03 Product Data

Product Data Sheets; G, RO

Computer Software; G, RO

The most recent versions of all computer software provided under this specification delivered as a Technical Data Package. Submit the user manuals for all software delivered for this project with the software.

Enclosure Keys

Certificate of Networthiness Documentation; G, AE

Documentation of existing Certificates of Networthiness or completed Certificate of Networthiness "Application Checklist" via e-mail and on optical disc.

SD-05 Design Data

UMCS IP Network Bandwidth Usage Estimate; G, RO

Four copies of the UMCS IP Network Bandwidth Usage Estimate.

SD-06 Test Reports

Pre-Construction QC Checklist; G, RO

Four copies of the Pre-Construction QC Checklist.

Post-Construction QC Checklist; G, RO

Four copies of the Post-Construction QC Checklist.

Existing Conditions Report; G, RO

Four copies of the Existing Conditions Report.
Start-Up and Start-Up Testing Report; G, RO

Four copies of the Start-Up and Start-Up Testing Report. The Start-Up and Testing report may be submitted as a Technical Data Package.

PVT Phase I Procedures; G, RO

Four copies of the PVT Phase I Procedures. The PVT Procedures may be submitted as a Technical Data Package.

PVT Phase I Report; G, RO

Four copies of the PVT Phase I Report. The PVT Phase I Report may be submitted as a Technical Data Package.

PVT Phase II Report; G, RO

Four copies of the PVT Phase II Report. The PVT Phase II Report may be submitted as a Technical Data Package.

SD-10 Operation and Maintenance Data

Operation and Maintenance (O&M) Instructions; G, RO

Four bound O&M Instructions and 2 copies of the Instructions in PDF format on optical disc. Index and tab bound instructions. Submit instructions in PDF form as a single PDF file, or as multiple PDF files with a PDF file table of contents containing links to the other files. O&M Instructions may be submitted as a Technical Data Package.

Preventive Maintenance Work Plan; G, RO

Four copies of the Preventive Maintenance Work Plan. The Preventive Maintenance Work Plan may be submitted as a Technical Data Package.

Basic Training Documentation; G, RO

Training manuals for Basic Training delivered for each trainee on the Course Attendance List with two additional copies delivered for archival at the project site. Submit two copies of the Course Attendance List with the archival copies. The Basic Training Documentation may be submitted as a Technical Data Package.

Advanced Training Documentation; G, RO

One set of training manuals delivered for each trainee on the Course Attendance List with two additional copies delivered for archival at the project site. Submit two copies of the Course Attendance List with the archival copies. The Advanced Training Documentation may be submitted as a Technical Data Package.

Refresher Training Documentation; G, RO

One set of training manuals delivered for each trainee on the Course Attendance List with two additional copies delivered for archival at the project site. Submit two copies of the Course Attendance List with the archival copies. The Refresher Training Documentation may be submitted as a Technical Data Package.

SD-11 Closeout Submittals

Closeout QC Checklist; G, RO

Four copies of the Closeout QC Checklist.

1.5 PROJECT SEQUENCING

TABLE I: PROJECT SEQUENCING specifies the sequencing of submittals as specified in paragraph SUBMITTALS (denoted by an 'S' in the 'TYPE' column) and activities as specified in PART 3 EXECUTION (denoted by an 'E' in the 'TYPE' column).

1.5.1 Sequencing for Submittals

The sequencing specified for submittals is the deadline by which the submittal must be initially submitted to the Government. Following submission there will be a Government review period as specified in Section 01 33 00 SUBMITTAL PROCEDURES. If the submittal is not accepted by the Government, revise the submittal and resubmit it to the Government within 14 days of notification that the submittal has been rejected. Upon re-submittal there will be an additional Government review period. If the submittal is not accepted the process repeats until the submittal is accepted by the Government.

1.5.2 Sequencing for Activities

The sequencing specified for activities indicates the earliest the activity may begin.

1.5.3 Abbreviations

In TABLE I the abbreviation AAO is used for 'after approval of' and 'ACO' is used for 'after completion of'.

TABLE I. PROJECT SEQUENCING

ITEM	TYPE	DESCRIPTION	SEQUENCING (START OF ACTIVITY or DEADLINE FOR SUBMITTAL)
1		Acceptance of Factory Test Report	
2	S	Existing Conditions Report	14 days after #1
3	S	Design Drawings - Meetings	
4	S	Design Drawings	14 days after #1
5	S	Product Data Sheets and Certificate of Networthiness Documentation	14 days after #1
6	S	UMCS IP Network Bandwidth Usage Estimate	14 days after #1
7	S	Pre-construction QC Checklist	14 days after #1
8	E	Install UMCS	AAO #2 thru #6

TABLE I. PROJECT SEQUENCING

ITEM	TYPE	DESCRIPTION	SEQUENCING (START OF ACTIVITY or DEADLINE FOR SUBMITTAL)
9	E	Start-Up and Start-Up Testing	ACO #7
10	S	Post-Construction QC Checklist	14 days ACO #8
11	S	Computer Software	14 days ACO #8
12	S	Start-Up and Start-Up Testing Report	14 days ACO #8
13	S	Draft As-Built Drawings	14 days ACO #8
14	S	PVT Phase I Procedures	14 days before scheduled start of #14 and AAO #11
15	E	PVT Phase I	AAO #13 and #12
16	S	PVT Phase I Report	14 days ACO #14
17	S	Preventive Maintenance Work Plan	AAO #11
18	S	O&M Instructions	AAO #11
19	S	Basic Training Documentation	AAO #11 and 14 days before scheduled start of #19
20	E	Basic Training (PVT Phase II)	AAO #16, #17 and #18
21	S	PVT Phase II Report	14 days ACO #19
22	S	Final As-Built Drawings	28 days AAO #20
23	S	Advanced Training Documentation	14 days before schedule start of #23 and AAO #18

TABLE I. PROJECT SEQUENCING

ITEM	TYPE	DESCRIPTION	SEQUENCING (START OF ACTIVITY or DEADLINE FOR SUBMITTAL)
24	E	Advanced Training	ACO #19, 14 days AAO #22, and no later than 60 days ACO #19
25	S	Refresher Training Documentation	14 days before #25 and AAO #18 and #22
26	E	Refresher Training	between 180 and 240 days ACO #19 and AAO #24
27	S	Cleanout QC Checklist	ACO #23

1.6 QUALITY CONTROL (QC) CHECKLISTS

The Contractor's Chief Quality Control (QC) Representative must complete the QC Checklist in APPENDIX A, and must submit the Pre-Construction QC Checklist, Post-Construction QC Checklist and Closeout QC Checklist as specified. The QC Representative must verify each item in the Checklist and initial in the provided area to indicate that the requirement has been met. The QC Representative must sign and date the Checklist prior to submission to the Government.

The APPENDIX A QC Checklist is available as an editable file at http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-10-10

1.7 OPERATION AND MAINTENANCE (O&M) INSTRUCTIONS

Provide UMCS Operation and Maintenance Instructions which include:

a. Procedures for the UMCS system start-up, operation and shut-down.

b. Final As-Built drawings.

c. Routine maintenance checklist, arranged in a columnar format: The first column listing all installed devices, the second column stating the maintenance activity or stating that no maintenance required, the third column stating the frequency of the maintenance activity, and the fourth column providing any additional comments or reference.

d. Qualified service organization list including points of contact with phone numbers.

e. Start-Up and Start-Up Testing Report.

f. Performance Verification Test (PVT) Procedures and Reports.

PART 2 PRODUCTS

2.1 EQUIPMENT REQUIREMENTS

2.1.1 Product Certifications

For computing devices, as defined in FCC Part 15, supplied as part of the UMCS provide devices which are certified to comply with the requirements of Class B computing devices.

2.1.2 Product Sourcing

For units of the same type of equipment, provide products of a single manufacturer. For each major component of equipment provide equipment with the manufacturer's name and the model and serial number in a conspicuous place. For materials and equipment, provide new standard unmodified products of a manufacturer regularly engaged in the manufacturing of such products.

2.1.3 General Requirements

Provide components that meet the following requirements:

a. Portions of the data communications equipment system installed in unconditioned spaces must operate properly in an environment with ambient temperatures between 32 and 120 degrees F and ambient relative humidity between 10 percent and 90 percent noncondensing.

b. Components must accept 100 to 125 volts AC (Vac), 60 Hz, single phase, three wire with a three-pronged, dedicated circuit outlet or be provided with a transformer to meet the component's power requirements.

c. The equipment must meet the requirements of NFPA 70, UL 60950, NFPA 262, FCC EMC, and FCC Part 15.

2.1.4 Nameplates

Provide nameplates of laminated plastic identifying the function, network address, if applicable, and identifier of the device. Laminated plastic must be at least 0.125 inch thick, white with black center core. Nameplates must be a minimum of 1 by 3 inch with minimum 0.25 inch high engraved block lettering.

2.1.5 Product Data Sheets

For all products (equipment) specified in PART 2 and supplied under this contract, submit copies of all manufacturer catalog cuts and specification sheets to indicate conformance to product requirements.

2.2 CONTROL HARDWARE

2.2.1 Control Protocol Routers

2.2.1.1 LonWorks/IP Router

Provide LonWorks/IP Routers which perform layer 3 routing of CEA-709.1-D packets over an IP network in accordance with CEA-852-C. The router must provide the appropriate connection to the IP network and connections to the CEA-709.3 TP/FT-10 or TP/XF-1250 network. LonWorks/IP Routers must

support the Dynamic Host Configuration Protocol (DHCP; IETF RFC 4361) for IP configuration and the use of an CEA-852-C Configuration Server (for CEA-852-C configuration), but must not rely on these services for configuration. LonWorks/IP Routers must be capable of manual configuration via a console RS-232 port.

2.2.1.2 Modbus/IP Router

Provide Modbus/IP Routers which perform layer 3 routing of MODBUS Protocol/ MODBUS TCP/IP packets over an IP network in accordance with MODBUS Protocol /MODBUS TCP/IP. The router must provide the appropriate connection to the IP network and connections to a non-IP MODBUS Protocol/MODBUS TCP/IP network. Modbus/IP Routers must support the Dynamic Host Configuration Protocol (DHCP; IETF RFC 4361) for IP configuration but must not rely on this service for configuration. Modbus/IP Routers must be capable of disabling the capability for remote configuration of Modbus routing information from the IP network.

2.2.2 Monitoring and Control (M&C) Controller Hardware

Provide Monitoring and Control (M&C) Controller Hardware which is a Niagara Framework Supervisory Gateway or a microprocessor-based direct digital control hardware and which communicates over the UMCS IP network using one of:

a. CEA-709.1-D in accordance with CEA-852-C and using only Standard Network Variable Types (SNVTs) as defined by the LonMark SNVT List.

b. ASHRAE 135 in accordance with ASHRAE 135 Annex J and using only Standard ASHRAE 135 services.

Monitoring and Control (M&C) Controller Hardware must either meet the requirements of the LonMark Interoperability Guide or be BTL Listed.

2.2.3 Control Protocol Gateways

Provide Control Protocol Gateways which perform bi-directional protocol translation between two of the following protocols, or between one of the following protocols and another protocol: CEA-709.1-D, Niagara Framework. Provide Control Protocol Gateways which also meet the following requirements.

a. Gateways must have two or more separate network connections, each appropriate for the protocol and media used. A single network connection must not be used for both protocols.

b. Gateways must be capable of being installed, configured and programmed through the use of instructions in the manual supplied by the Contractor.

c. Provide and license to the Government all software required for gateway configuration.

d. Gateways must retain their configuration after a power loss of an indefinite time, and must automatically return to their pre-power loss state once power is restored.

e. Gateways must provide capacity for mapping all required points as indicated plus an additional 10 percent between the two protocols it

uses.

f. Gateways must, in addition, meet all requirements specified (in the following subparagraphs) for each of the two protocols it translates.

2.2.3.1 Gateway for CEA-709.1

For a gateways using CEA-709.1-D provide gateways which meet the following requirements in addition to the requirements for all gateways:

a. It must allow bi-directional mapping of data in the Gateway to Standard Network Variable Types (SNVTs) according to the LonMark SNVT List.

b. Gateways communicating CEA-709.1-D over an IP network must communicate in accordance with CEA-852-C.

c. It must allow of its standard network variables (SNVTs) and support transmitting data using the "min, max, and delta" (throttling and heartbeat) methodology.

d. It must provide the ability to label SNVTs.

e. It must supply a LonMark external interface file (XIF) as defined in the LonMark XIF Guide for use with LNS tools and utilities.

f. It must have a "service pin" which, when pressed, will cause the Gateway to broadcast its 48-bit NodeID and ProgramID over the network.

g. It must provide a configurable self-documenting string.

2.2.3.2 Niagara Framework Supervisory Gateway

Niagara Framework Supervisory Gateway Hardware must:

a. be direct digital control hardware.

b. have an unrestricted interoperability license and a Niagara Compatibility Statement (NiCS) that follows the Tridium Open NiCS Specification.

c. manage communications between a field control network and the Niagara Framework Monitoring and Control Software and between itself and other Niagara Framework Supervisory Gateways. Niagara Framework Supervisory Gateway Hardware must use Fox protocol for communication with other Niagara Framework Components.

d. be fully programmable using the Niagara Framework Engineering Tool and support the following:

(1) Time synchronization, Calendar, and Scheduling using Niagara Scheduling Objects

(2) Alarm generation and routing using the Niagara Alarm Service

(3) Trending using the Niagara History Service and Niagara Trend Log Objects

(4) Integration of field control networks using the Niagara Framework

Engineering Tool

(5) Configuration of integrated field control system using the Niagara Framework Engineering Tool when supported by the field control system

e. meet the following minimum hardware requirements:

(1) One 10/100 Mbps Ethernet Port

(2) One port compatible with the field control system to be integrated using this product.

f. provide access to field control network data and supervisory functions via web interface and support a minimum of 16 simultaneous users

2.3 COMPUTER HARDWARE

For computer hardware furnished under this specification provide standard products of a single manufacturer which advertises service in all 48 contiguous states, and provide only model currently in production. Except for PCI-E cards installed into expansion slots provided in a desktop or server computer in order to meet the requirements of this specification, do not modify computer hardware from the manufacturer configuration.

2.3.1 Server Hardware

Computer Server Hardware (server) must be a desktop or server computer meeting the following minimum requirements:

2.3.1.1 Processor

Quad-core processor designed for server applications. Processor speed must be at least 50 percent of the speed of the fastest Intel server processor commercially available.

2.3.1.2 Random Access Memory (RAM)

300 percent of the recommended requirements of the software to be installed on the server and no less than 24GB.

2.3.1.3 Communications Ports

Four USB ports.

2.3.1.4 Hard Drives

2.3.1.4.1 Internal Hard Drives

Hard drives with SATA-3 Controller providing at least 2TB usable disk space. Hard drives must use RAID (Redundant Array of Inexpensive Disks) at levels 1 or 5 (RAID-1 or RAID-5).

2.3.1.4.2 External Hard Drive

4TB disk space with a USB 3.0 interface.

2.3.1.5 Optical Drive

Blueray burner drive.

2.3.1.6 Video Output

32-bit color at a minimum resolution of 1920 by 1080 at a minimum refresh rate of 70 Hz and a DVI or display port output.

2.3.1.7 Network Interface

Two integrated 1000Base-T Ethernet with RJ45 connector.

2.3.1.8 Monitor

Widescreen flat panel LCD monitor sized as indicated but no less than 24 inch nominal with a minimum resolution of 1600 by 1050 pixels and a minimum refresh rate of 70Hz.

2.3.1.9 Keyboard

101 key wired USB keyboard having a minimum 64 character standard ASCII character set based on ANSI INCITS 154 and an integral smart card reader compatible with a Department of Defense Common Access Card (CAC).

2.3.1.10 Mouse

2-button wired USB optical scroll mouse with a minimum resolution of 400 dots per inch.

2.3.1.11 Power Supplies

Hot-swappable redundant power supplies.

2.3.2 Workstation Hardware (Desktop and Laptop)

Provide a standard desktop computer or a laptop meeting the following minimum requirements for the Computer Workstation Hardware (workstation) as indicated.

2.3.2.1 Processor

2.3.2.1.1 Desktop

Quad-core processor designed for desktop applications. Processor speed must be at least 75 percent of the speed of the fastest Intel desktop processor commercially available.

2.3.2.1.2 Laptop

Quad-core processor designed for laptop applications. Processor speed must be at least 50 percent of the speed of the fastest Intel laptop processor commercially available.

2.3.2.2 Random Access Memory (RAM)

300 percent of the recommended requirements of the software to be installed on the server and no less than 8GB.

2.3.2.3 Communications Ports

2.3.2.3.1 Desktop

Six USB ports.

2.3.2.3.2 Laptop

Two USB ports, plus a PCMCIA card slot or an additional USB port, plus an integral RS-232 serial port or an additional USB port and a USB to RS-232 serial adapter.

2.3.2.4 Hard Drive and Controller

2.3.2.4.1 Desktop

1.5TB or larger with a SATA-3 controller.

2.3.2.4.2 Laptop

250GB or larger solid state drive.

2.3.2.5 Optical Drive

DVD-RW drive

2.3.2.6 Video Output

2.3.2.6.1 Desktop

32-bit color with dual monitor support minimum resolutions of 1920 by 1080 at minimum refresh rates of 70 Hz and dual DVI or display port outputs.

2.3.2.6.2 Laptop

32-bit color with a minimum resolution of 1920 by 1080 at minimum refresh rates of 70 Hz and VGA or HDMI output.

2.3.2.7 Network Interface

2.3.2.7.1 Desktop

Integrated 1000Base-T Ethernet with RJ45 connector.

2.3.2.7.2 Laptop

Integrated 1000Base-T Ethernet with RJ45 connector and an integrated IEEE 802.11b/g/n wireless interface. The Laptop must have a physical switch for activation and deactivation of the wireless interface.

2.3.2.8 Monitor

2.3.2.8.1 Desktop

Dual widescreen flat panel LCD monitors sized as indicated but no less than 24 inch nominal with minimum resolutions of 1920 by 1080 pixels and a minimum refresh rate of 70Hz.

2.3.2.8.2 Laptop

LCD Screen sized as indicated but no less than 325 mm 13 inch nominal with a maximum supported resolution of no less than 1600 by 900 pixels.

2.3.2.9 Keyboard and Smart Card Reader

2.3.2.9.1 Desktop

101 key wired USB keyboard having a minimum 64 character standard ASCII character set based on ANSI INCITS 154 and an integral smart card reader compatible with a Department of Defense Common Access Card (CAC).

2.3.2.9.2 Laptop

Standard laptop keyboard. Internal smart card reader compatible with a Department of Defense Common Access Card (CAC).

2.3.2.10 Mouse

2.3.2.10.1 Desktop

2-button wired USB optical scroll mouse with a minimum resolution of 400 dots per inch.

2.3.2.10.2 Laptop

Integrated touch-pad plus a 2-button wired USB optical scroll mouse with a minimum resolution of 400 dots per inch.

2.3.3 Printers

Provide local or network printers as indicated. Provide local printers which have a USB interface. Provide network printers which have a 100Base-T or faster interface with an RJ45 connection and a firmware print spooler compatible with the Operating System print spooler.

2.3.3.1 Alarm Printer

Provide alarm printers which use sprocket-fed fanfold paper with adjustable sprockets for paper width up to 11 inches. Alrm printers must have programmable control of top-of-form. Provide floor stands with paper racks for alarm printers.

2.3.3.2 Laser Printer

Provide laser printers as indicated meeting the following minimum requirements:

Resolution	600 by 600 dots per inch
Printing Time	10 pages per minute
Data Buffer Size	16 Megabytes
Media Type	Paper and transparency film

Media Size	ANSI A(8.5 by 11 inches) and other sizes as indicated
Paper Cassette	250 sheet capacity

2.4 COMPUTER SOFTWARE

2.4.1 Operating System (OS)

Provide the latest version of the Army Gold Master Windows Operating System. The Operating System media will be furnished by the Government. The Government will provide the Operating System license.

2.4.2 Office Automation Software

Provide Office Automation Software consisting of the e-mail, spreadsheet and word processing portions of the project site's standard office automation software.

2.4.3 Virus Protection Software

Provide Virus Protection Software consisting of the project site's standard virus protection software complete with a virus definition update subscription.

2.4.4 Disk Imaging (Backup) Software

Provide Disk imaging (backup) software consisting of the project site's standard disk imaging software.

2.4.5 M&C Controller Hardware Configuration Software

Provide M&C Controller Hardware Configuration Software consisting of the software required to configure, program, or configure and program each Monitoring and Control (M&C) Controller Hardware provided for the functions it performs.

2.4.6 Niagara Framework Engineering Tool

Provide Niagara Workbench or an equivalent Niagara Framework engineering tool software which:

a. has unrestricted interoperability license and a Niagara Compatibility Statement (NiCS) which follows the Tridium Open NiCS Specification.

b. is capable of performing network configuration for Niagara Framework Supervisory Gateways and Niagara Framework Monitoring and Control Software.

c. is capable of programming and configuring Niagara Framework Supervisory Gateways and Niagara Framework Monitoring and Control Software.

d. is capable of discovery of Niagara Framework Supervisory Gateways and all points mapped into each Niagara Framework Supervisory Gateway and making these points accessible to Niagara Framework Monitoring and Control Software.

2.4.7 Monitoring and Control (M&C) Software

Provide monitoring and control (M&C) software which is a client-server software package with a graphical user interface (GUI) using web-browser based clients. Provide Niagara Framework Web Supervisor or equivalent Niagara Framework monitoring and control software which communicates with Niagara Framework field control systems using the Fox protocol. The M&C Software may support other field control protocols.

Provide a single software package which implements the Scheduling, Alarming, Trending, Graphical System Display, and System Display Editor functionality. Other specified M&C functionality may be implemented in the same software package or in additional software packages. As specified in PART 3 EXECUTION, the M&C Software must operate on Server hardware, except that software for Point Calculations and Demand Limiting may operate on M&C Controller Hardware.

2.4.7.1 M&C Software License

License the M&C Software as specified. Use of multiple copies of M&C Server software working in coordination and sharing data between them such that they function as, and appear to an operator as, a single M&C Server is permitted to meet these requirements.

2.4.7.1.1 Network Points

For Niagara Framework systems, a network point is a point brought directly into the Web Supervisor M&C Software through a protocol other than the Fox Protocol and via a Niagara Framework Supervisory Gateway. Provide M&C Software and licensing to support no less than than 1000 network points, and to be capable of expansion to support no less than 50,000 network points.

2.4.7.1.2 Web Clients

Provide M&C Software and licensing to support no less than 10 simultaneous web clients with no limit on the total number of web clients. M&C Software must be capable of expansion to support no less than 30 simultaneous web clients.

2.4.7.1.3 Calculations

Provide M&C Software and licensing to support no less than one calculated point for every ten network points (see "Network Points" above).

2.4.7.1.4 Other Points

For installations using M&C Software installed on M&C Controller Hardware (as opposed to Server hardware), provide additional licensing to support additional network points for the communications between portions of the M&C Software installed on different hardware. For example, if the Calculations requirement is performed by M&C Software installed on Controller hardware, the M&C Software must be licensed for additional network points to cover the network points required for communication between the Controller hardware and the Server hardware.

2.4.7.1.5 Alarming

Provide M&C Software and licensing to support the handling (routing) of alarms for no less than 10,000 points.

2.4.7.1.6 Trending

Provide M&C Software and licensing to support a minimum of 8,000 simultaneous trends.

2.4.7.1.7 Niagara Framework Open License

Provide M&C Software with an unrestricted interoperability license and a Niagara Compatibility Statement (NiCS) which follows the Tridium Open NiCS Specification.

2.4.7.2 M&C Software Update Licensing

In addition to all other licensing requirements, provide M&C Software licensing which includes licensing of the following software updates for a period of no less than 5 years:

a. Security and bug-fix patches issued by the M&C Software manufacturer.

b. Security patches to address any vulnerability identified in the National Vulnerability Database at http://nvd.nist.gov with a Common Vulnerability Scoring System (CVSS) severity rating of MEDIUM or higher.

2.4.7.3 Supported Field Control Protocols

Provide M&C Software which supports field control protocols as follows:

e. The Software must use the Niagara Framework and must communicate with Niagara Framework Supervisory Gateways using the Fox protocol.

f. The M&C Software may, in addition, include drivers to other protocols.

Provide M&C Software capable of reading values from and writing values to points via any supported field protocol, and capable of reading values from one field protocol and writing them to another. All points obtained from any field protocol must be available to all M&C Software functionality.

2.4.7.4 Supported Enterprise Protocols

Provide M&C Software which supports oBIX, BACnet Web Services or OPC as an enterprise protocol and which meets the following requirements:

a. It is able to read values from any point or collection of points (network point, internal point, trend log or schedule) and transmit these values via the enterprise protocol.

b. It is able to receive data via the enterprise protocol and use this data to change the value of any point.

c. License the enterprise protocol interface to the project site and document he interface such that any system capable of communicating

with that protocol can be used to read and write data from the M&C Software.

2.4.7.5 Point Information

Every point, both network and internal, in the M&C Software must contain the following fields:

2.4.7.5.1 Name

A configurable name used for identification of the point within the M&C Software.

2.4.7.5.2 Description

A configurable description of no less than 80 alpha-numeric characters.

2.4.7.5.3 Value

A field containing the current point value.

2.4.7.5.4 Units

A field containing the engineering units.

2.4.7.5.5 Source

A field identifying the source of the point. For network points, this is generally the address or identification of the field device (for example, the Domain-Subnet-Node address for LonWorks field control devices or the DeviceID for BACnet devices).

2.4.7.6 Point Calculations

Provide M&C software capable of performing calculations and computing the value of a calculated point based on the values of two or more network points and calculated points. Mathematical operators must include: addition, subtraction, multiplication, division, exponentiation (y^x, power), square root, reciprocal, natural logarithm, sin, cos, tan, arcsin, arccos, arctan, and parenthesis. Pi and e must be available as constants for use in calculations.

2.4.7.7 Browser-Based Graphical User Interface (GUI)

Provide M&C Software which includes a web-browser based (client-server) graphical user interface through which all M&C Software functionality, except for the Graphics Editor, System Display Editor, report configuration, point calculation configuration, and enterprise protocol configuration, is accessible.

Provide graphical user interface web server and web clients meeting the following requirements:

a. The web server must use HTTPS based on the Transport Layer Security (TLS) Protocol in accordance with IETF RFC 7465 using a Government-furnished certificate.

b. The graphical user interface must be Common Access Card (CAC) enabled: It must support web client authentication using certificates obtained

from a Department of Defense Common Access Card (CAC) Smart Card.

c. The web client must operate on any version of Windows currently supported by Microsoft.

d. The web client must function in the most recent three version of Internet Explorer and the most recent three versions of Firefox.

e. The web client must not require a connection to any server other than the M&C Server.

f. The web client must function in a browser with Java, Shockwave, Silverlight, and Flash installed. The client may require a download of mobile code from the M&C Server, but must not require the download of additional browser plug-ins or add-ins and there must be no limit on the number of downloads. The client must not require ActiveX.

2.4.7.8 Passwords

Provide M&C software with user-based access control to M&C functionality. The M&C Software must recognize at least 100 separate users and have at least 4 levels of user permissions. User permission levels (from most restrictive to most permissive) must include:

a. Permission Level 1: View-only access to the graphical user interface.

b. Permission Level 2: Permission Level 1 plus acknowledge alarms and set up (configure) trends and reports.

c. Permission Level 3: Permission Level 2 plus override points and set up (configure) alarms, schedules and demand limiting.

d. Permission Level 4: Permission Level 3 plus create and modify Graphical System Displays using the System Display Editor.

Passwords must not be displayed and must not be logged. The system must maintain a disk file on the server hardware logging all activity of the system. This file must maintain, as a minimum, a record of all operators logged onto the system, alarm acknowledgments, commands issued and all database modifications. If the file format is not plain ASCII text, provide a means to export or convert the file to plain ASCII text. Provide a mechanism for archiving the log files for long term record storage.

2.4.7.9 Graphical System Displays

Provide graphical displays consisting of building system (air handler units, VAV boxes, chillers, cooling towers, boilers, etc.) graphic displays. Data associated with an active display must be updated at least once every 5 seconds.

2.4.7.9.1 Navigation Scheme

System graphic displays of building systems and points must be hierarchical displays using a building-to-equipment point-and-click navigation scheme which allows navigation from a garrison-wide display, through a building-wide display to the individual units. Each display must show the building name and number. Each display must show system wide data such as outside air temperature and humidity in the case of an HVAC

system application.

a. For each Building or Building Sub-Area display, show the building foot print and basic floor plan, and clearly show and distinguish between the individual zones and the equipment serving each zone and space. Show all space sensor and status readings, as applicable, for the individual zones such as space temperature, humidity, occupancy status, etc. Show the locations of individual pieces of monitored and controlled equipment.

b. For each equipment display show a 3-dimensional representation of the individual pieces of equipment using the symbols and M&C point data types as specified. Use different colors and textures to indicate various components and real time data. Use consistent color and texture meanings across all displays.

c. Provide displays which clearly distinguish between the following point data types and information:

(1) Real-time data.

(2) Other user-entered data.

(3) Devices in alarm (unacknowledged).

(4) Out-of-range, bad, or missing data.

(5) Points which are overridden.

2.4.7.9.2 Navigation Commands

Provide system displays which support English language operator commands via point-and-click mouse or keyboard entry for defining and selecting points, parameters, graphics, report generation, and all other functions associated with operation. The operator commands must be usable from any operator workstation with individual operator passwords as specified.

2.4.7.10 Graphic Editor

Provide a fully featured graphics editor and capable of creating custom graphics and graphic symbols for use by the System Display Editor.

2.4.7.11 System Display Editor

Provide a system display editor which allows the user to create, modify, and delete graphic displays. The display editor may have a separate user interface and is not required to be accessible via the web browser interface. Provide a display editor which includes the following functions:

a. Create and save displays. Save an existing or modified display as a new display (i.e. "save as")

b. Group and ungroup graphics, where graphics include both alphanumeric and graphic symbols, and where a grouped graphic is manipulated as a single graphic.

c. Place, locate, resize, move, remove, reposition, rotate and mirror a graphic on a display.

d. Overlay graphics over other graphics and assign depths such that when there are coincident graphics the one on top is visible.

e. Modify graphic properties based on the value of network points and create conditions governing the display of a graphics such that different graphics are visible based on the value of network points or calculated points

f. Integrate real-time data with the display.

g. Establish connecting lines.

h. Establish sources of latest data and location of readouts.

i. Display analog values as specified.

j. Assign conditions which automatically initiate a system display.

k. Include library of display symbols which include: Pump, Motor, Two- and Three-way Valves, Flow Sensing Element, Point and Averaging Temperature Sensors, Pressure Sensor, Humidity Sensor, Single and Double Deck Air Handling Unit, Fan, Chiller, Boiler, Air Compressor, Chilled Water Piping, Steam Piping, Hot Water Piping, Ductwork, Unit Heater, Pressure Reducing Valve, Damper, Electric Meter, Limit Switch, Flow Switch, High- and Low- Point and Averaging Temperature Switches, High- and Low- Pressure Switches, Coil, Solenoid Valve, Filter, Condensing Unit, Cooling Tower, Variable Frequency Drive (VFD), Heat Exchanger, Current Sensing Relays, Generator, Circuit Breaker, Transformer, Tank. Symbols must at a minimum conform to ASHRAE FUN IP where applicable.

2.4.7.12 Scheduling

d. The M&C software must be capable of performing time synchronization and configuring Niagara Framework Schedule Objects in Niagara Framework Supervisory Gateways.

e. The M&C Software must include a scheduling graphic display, accessible via the graphical user interface, with the following fields and functions:

(1) Current date and time.

(2) System identifier(s) and name(s), including location information such as Building name(s) and number(s).

(3) System group. Systems grouped by the user to perform according to a common schedule.

(4) Weekly schedules. For each system, a weekly schedule based on a seven day per week schedule with independent schedules for each day of the week including no less than 6 value changes per day.

(5) Holiday and special event schedules. Support for holiday and special event calendar schedules independent of the daily schedule. Special event schedules include one-time events and recurring events. Scheduling of one-time events include the beginning and ending dates and times of the event. Holiday and

special event schedules must have precedence over device weekly schedules.

2.4.7.13 Alarms

Provide M&C Software meeting the following minimum requirements for alarms:

a. The M&C software must be capable of configuring alarms in Niagara Framework Supervisory Gateways using the Niagara Alarm Service.

b. The M&C software must be capable of handling (routing) alarms received from a Niagara Framework Supervisory Gateway.

c. The M&C software must support Niagara Framework Alarm Classes.

d. The M&C software must support at least two alarm priority levels: critical and informational. Critical alarms must remain in alarm until acknowledged by an operator and the alarm condition no longer exists; informational alarms must remain in alarm until the alarm condition no longer exists or until the alarm is acknowledged.

e. The creation, modification, and handling (routing) of alarms must be fully accessible and fully adjustable from the graphical user interface.

f. Alarm Data. Alarm data to be displayed and stored must include:

(1) Identification of alarm including building, system (or sub-system), and device name.

(2) Date and time to the nearest second of occurrence.

(3) Alarm type:

(a) Unreliable: Indicates that the source device has failed due to the sensing device or alarm parameter being out-of-range or bad data.

(b) High Alarm.

(c) Low Alarm.

(4) Current value or status of the alarm point, including engineering units

(5) Alarm limits, including engineering units.

(6) Alarm priority.

(7) Alarm Message: A unique message with a field of at least 60 characters. Assignment of messages to an alarm must be an operator editable function.

(8) Acknowledgement status of the alarm including the time, date and user of acknowledgement.

g. Alarm Notification and Routing: The M&C software must be capable of performing alarm notification and routing functions. Upon receipt of the M&C software must immediately perform alarm notification and routing according to an assigned routing for that alarm. The M&C

software must support at least 100 alarm routes, where an alarm route is a unique combination of any of the following activities:

(1) Generate a pop-up up active clients. The pop-up display must include the Alarm Data. Alarms must be capable of being acknowledged from the pop-up display by operators with sufficient permissions. Pop-up must be displayed until acknowledged.

(2) Send an e-mail message via simple mail transfer protocol (SMTP; RFC 821). The e-mail must contain a configurable message and all alarm data. The e-mail recipient and scripted message must be user configurable for each alarm route.

(3) Print alarms to designated alarm printers. The printed message must be the same as the pop-up message.

h. Alarm Display and Acknowledgement. The M&C software must include an alarm display. Alarms must be available for display at each workstation as shown, along with all associated alarm data. Alarms must be capable of being acknowledged from this display. Multiple alarms must be capable of being acknowledged using a single command. Operator acknowledgment of one alarm must not automatically be considered as acknowledgment of any other alarm nor may it inhibit reporting of subsequent alarms.

i. Alarm Storage and Reports: The M&C software must store each alarm and its associated alarm data to hard disk and retain this information after the alarm no longer exists. The stored data must be sortable, searchable, and printable.

2.4.7.14 Trending

Provide M&C software capable of using the Niagara history service to create, modify, upload and archive trend log objects in Niagara Framework Supervisory Gateways.

a. The M&C Software must include a graphical display for trend configuration, creation and deletion accessible through the graphical user interface. Each trend must be user-configurable for:

(1) Point to trend.

(2) Sampling interval: adjustable between 1 second and 1 hour.

(3) Start and Stop Time of Trend: Start and stop times determined by one or more of the following methods:

(a) Start time and stop time

(b) Start time and duration

(c) Start time and number of samples

b. The M&C software must be capable of displaying and printing a graphical representation of each trend, and of multiple trended points on the same graph. The software must be capable of saving trend logs to a file. If the file format is not plain ASCII text in a Comma-Separated-Value (CSV) format, provide a means to export or convert the file to plain ASCII text in a CSV format.

2.4.7.15 Electrical Power Demand Limiting

Provide M&C software which includes demand limiting functionality capable of performing electrical demand limiting such that it can change the occupancy mode or setpoint of field control system hardware via a network point based on a projected demand in order to maintain demand below a configured target. The demand target must incorporate real-time pricing data. The demand limiting algorithm must incorporate priority levels such that low priority equipment is adjusted before high-priority equipment. The demand limiting algorithm must generate a critical alarm when it begins to impact the system and a critical alarm if the demand target is exceeded.

2.4.7.16 Report Generation

Provide M&C Software capable of generating, saving and printing reports. Dynamic operation of the system must not be interrupted to generate a report. The report must contain the time and date when the samples were taken, and the time and date when the report was generated. The software must be capable of saving reports to a PDF file and to a file compatible with the provided Office Automation Software.

The software must allow for automatic and manual generation of reports. For automatic reports an operator must be able to specify the time the initial report is to be generated, the time interval between reports, end of period, and the output format for the report. Manual report generation must allow for the operator to request at any time the output of any report.

2.4.7.17 Custom Report Generation

Provide M&C software capable of generating custom reports, including but not limited to the following standard reports:

2.4.7.17.1 Electrical Power Usage Report

An electrical power Usage summary, operator selectable for substations, meters, or transducers, individual meters and transducers, any group of meters and transducers, and all meters for an operator selected time period. The report must include the voltage, current, power factor, electrical demand, electrical power consumption, reactive power (Kvar) for each substation, facility, system or equipment as selected by the operator. The report must be automatically printed at the end of each summary period and include:

a. Total period consumption.

b. Demand interval peak for the period, with time of occurrence.

c. Energy consumption (kWh) over each demand interval.

d. Time-of-use peak, semi-peak, off-peak, or baseline total kWh consumption.

e. Reactive power during each demand interval.

f. Power factor during each demand interval.

g. Outside air (OA) temperature and relative humidity (RH) taken at the

maximum and minimum of OA temperature of the report period with the time and dates of occurrence. At the installation's peak demand interval, the OA temperature and RH must also be recorded.

h. Calculated heating and cooling degree days based on a 65 degrees F balance point.

2.4.7.17.2 Electrical Peak Demand Prediction Report

A report based on the demand limiting program, which includes:

a. Electrical Demand Target (EDT).

b. Actual peak and predicted peak for each demand interval for that day.

c. Predicted demand for the next demand interval.

2.4.7.17.3 Energy usage Report

An energy usage summary, operator selectable, for a unit, building, area, installation, and the entire UMCS. The report must be divided by utility, and must be capable of reporting on at least four separate utilities. The report must include the following information:

a. Beginning and ending dates and times.

b. Total energy usage for each utility for the current and previous day.

c. Total energy usage for each utility for the current and previous month.

d. Maximum 15-minute interval average rate of consumption for each utility for the current and previous day and current and previous month.

e. Outside air (OA) temperature and OA humidity for current and previous month and current and previous day:

(1) Average temperature and humidity.

(2) Temperature and humidity at maximum and minimum OA temperature with time and date of occurrence.

(3) Temperature and humidity at maximum and minimum humidity with time and date of occurrence.

(4) Temperature and humidity at the installation's peak demand interval with the time and date of occurrence

f. Calculated degree days. Reports which include humidity must be configurable to report either dewpoint or relative humidity.

2.4.7.17.4 Water Usage Report

A water usage summary, operator selectable, for a unit, building, area, installation, and the entire UMCS. The report must include the following information:

a. Beginning and ending dates and times.

b. Total energy water usage for the current and previous day.

c. Total water usage for the current and previous month.

2.4.7.17.5 Alarm Report

Outstanding alarms by building or unit, including time of occurrence.

2.4.7.17.6 M&C Software Override Report

Points overridden by the M&C Software, including time overridden, and identification of operator overriding the point.

2.4.7.17.7 Run Time Reports

A report totalizing the accumulated run time of individual pieces of equipment. The operator must be able to define equipment groupings and to generate reports based on these groupings.

2.4.7.17.8 Cooling Tower Profiles

A cooling tower profile for each cooling tower as indicated, including:

a. Total daily and monthly on-time (each fan).

b. Number of on and off transitions (each fan).

c. Maximum and minimum daily condenser water temperature and the time of occurrence for the current and previous months.

d. Total daily and monthly makeup water consumption.

2.4.7.17.9 Chiller usage Report

A report of the operation of each chiller as shown on a daily and monthly basis, for each of at least 10 discrete loading levels. The report must include:

a. Average power for the month at each level in kW

b. Total monthly energy use in kWh at each level

c. Total monthly energy use in kWh for the chiller (all levels)

d. Total daily run hours at each level

e. Total Monthly run hours at each level

2.4.7.17.10 Device Offline Report

A report listing all offline devices in all building control systems integrated to the M&C Software and all offline Niagara Framework Supervisory Gateways.

2.5 UNINTERRUPTIBLE POWER SUPPLY (UPS)

Provide uninterruptible power supplies (UPS) as self contained devices suitable for installation and operation at the location of Server and Workstation hardware and sized to provide a minimum of 20 minutes of

operation of the connected hardware. Equipment connected to the UPS must not be affected in any manner by a power outage of a duration less than the rated capacity of the UPS. Provide the UPS complete with all necessary power supplies, transformers, batteries, and accessories. Provide UPS which include visual indication of normal power operation, UPS operation, abnormal operation and visual and audible indication of AC input loss and low battery power. Provide UL 1778 approved UPS. UPS powering Server Hardware must notify the server via USB interface of impending battery failure.

2.6 RACKS AND ENCLOSURES

2.6.1 Enclosures

Enclosures supplied as an integral (pre-packaged) part of another product are acceptable. Provide two Enclosure Keys for each lockable enclosure on a single ring per enclosure with a tag identifying the enclosure the keys operate. Provide enclosures meeting the following minimum requirements:

2.6.1.1 Outdoors

For enclosures located outdoors, provide enclosures meeting NEMA 250 Type 4 requirements.

2.6.1.2 Mechanical and Electrical Rooms

For enclosures located in mechanical or electrical rooms, provide enclosures meeting NEMA 250 Type 4 requirements.

2.6.1.3 Other Locations

For enclosures in other locations including but not limited to occupied spaces, above ceilings, and in plenum returns, provide enclosures meeting NEMA 250 Type 1 requirements.

2.6.2 Equipment Racks

Provide standard 19 inch equipment racks compatible with the electronic equipment provided. Racks must be either aluminum or steel with bolted or welded construction. Steel equipment racks must be painted with a flame-retardant paint. Guard rails must be included with each equipment rack and have a copper grounding bar installed and grounded to the earth.

PART 3 EXECUTION

3.1 EXISTING CONDITIONS SURVEY

Perform a field survey, including but not limited to testing and inspection of equipment to be part of the UMCS, and submit an Existing Conditions Report documenting the current status and its impact on the Contractor's ability to meet this specification. For field control systems to be integrated to the UMCS which are not already connected to the UMCS IP network, verify the availability of the building network backbone at the FPOC location, and verify that FPOCs shown as existing are installed at the FPOC location.

3.2 DRAWINGS AND CALCULATIONS

3.2.1 UMCS IP Network Bandwidth Usage Estimate

Provide a UMCS IP Network Bandwidth Usage Estimate for this project. In this estimate account for field control systems using all M&C required protocols and the integration of field control system via gateways. Define all assumptions used to create the estimate, including but not limited to: trending, fast trends for commissioning, schedules, alarms, and display of system graphics.

3.2.2 Certificate of Networthiness Documentation

For all software provided, provide documentation that an Enterprise Certificate of Networthiness exists, that a Limited Certificate of Networthiness applicable to the project site exists, or provide a completed Certificate of Networthiness "Application Checklist".

3.2.3 UMCS Contractor Design Drawings

After the submission of the existing conditions report and prior to the development of UMCS Contractor Design Drawings, a coordination meeting including DPW, USACE, the Contractor, and the A/E is required to review all BAS controls and integration into the existing UMCS.

Revise and update the Contract Drawings to include details of the system design and all hardware components, including contractor provided and Government furnished components. Details to be shown on the Design Drawing include:

a. The logical structure of the network, including but not limited to the location of all Control Hardware (including but not limited to each Control Protocol Gateway, Control Protocol Router, Niagara Framework Supervisory Gateway and Monitoring and Control (M&C) Controller).

b. Manufacturer and model number for each piece of Computer Hardware and Control Hardware.

c. Physical location for each piece of Computer Hardware and Control Hardware.

d. Version and service pack number for all software and for all Control Hardware firmware.

3.2.4 As-Built Drawings

Prepare draft as-built drawings consisting of Points Schedule drawings for the entire UMCS, including Points Schedules for each Gateway, and an updated Design Drawing including details of the actual installed system as it is at the conclusion of Start-Up and Start-Up Testing. Provide As-Built Drawings which include details of all hardware components, including contractor provided and Government furnished components. In addition to the details shown in the design drawings, the as-built drawing must include:

a. IP address(es) and Ethernet MAC address(es) as applicable for each piece of Control Hardware (including but not limited to each Niagara Framework Supervisory Gateway, Control Protocol Gateway, Control Protocol Router, and Monitoring and Control (M&C) Controller).

b. IP address and Ethernet MAC address for each computer server, workstation, and networked printer.

c. Network identifier (name) for each printer, computer server and computer workstation.

d. List of ports, protocols and network services for each device connected to an IP network.

e. Network Addresses: Niagara Framework Station ID for all Niagara Framework components including but not limited to Niagara Framework Supervisory Gateways and the Web Supervisor.

Prepare Draft As-Built Drawings upon the completion of Start-Up and Start-Up Testing and Final As-Built Drawings upon completion of PVT Phase II.

3.3 INSTALLATION REQUIREMENTS

3.3.1 General

Install system components as shown and specified and in accordance with the manufacturer's instructions and provide necessary interconnections, services, and adjustments required for a complete and operable system. Install communication equipment and cable grounding as necessary to preclude ground loops, noise, and surges from adversely affecting system operation. Install Fiber Optic cables and wiring in exposed areas, including low voltage wiring but not including network cable in telecommunication closets, in metallic raceways or EMT conduit as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Do not install equipment in any space which experiences temperatures or humidity outside of the rated operating range of the equipment.

3.3.2 Isolation, Building Penetrations and Equipment Clearance

Provide dielectric isolation where dissimilar metals are used for connection and support. Make all penetrations through and mounting holes in the building exteriors watertight. Drill or core drill holes in concrete, brick, steel and wood walls with proper equipment. Seal conduits installed through openings with materials which are compatible with existing materials. Seal openings with materials which meet the requirements of NFPA 70 and SECTION 07 84 00 FIRESTOPPING.

3.3.3 Nameplates

Provide Nameplates for all Control Hardware and all Computer Hardware. Attach Nameplates to the device in a conspicuous location.

3.4 INSTALLATION OF EQUIPMENT

3.4.1 Wire and Cable Installation

Install system components and appurtenances in accordance with NFPA 70, manufacturer's instructions and as indicated. Provide necessary interconnections, services, and adjustments required for a complete and operable signal distribution system. Label components in accordance with TIA-606. Firestop Penetrations in fire-rated construction in accordance with Section 07 84 00 FIRESTOPPING. Install conduits, outlets and

raceways in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Install wiring in accordance with TIA-568-C.1 and as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Mark wiring terminal blocks and outlets in accordance with TIA-606. Do not install non-fiber-optic cables in the same cable tray, utility pole compartment, or floor trench compartment with power cables. Properly secure and install neat in appearance cables not installed in conduit or raceways.

3.4.2 Grounding

Install signal distribution system ground in accordance with TIA-607 and Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Connect equipment racks to the electrical safety ground.

3.4.3 Power-Line Surge Protection

Protect equipment connected to ac circuits must be protected against or withstand power-line surges. Provide equipment protection which meets the requirements of IEEE C62.41. Do not use fuses for surge protection.

3.4.4 IP Addresses

For all Control Hardware requiring an IP address on the UMCS IP Network, coordinate with the NEC to obtain IP addresses.

3.4.5 Computer Hardware and Software

3.4.5.1 Hardware Installation

Install Computer Hardware as specified and indicated. Power Computer Servers through a UPS, and install and configure them such that the server automatically undergoes a clean shutdown upon low battery signal from the UPS.

3.4.5.2 Software Installation

Install software as follows:

a. Niagara Framework Engineering Tool: Install the Niagara Framework Engineering Tool on the Web Supervisor Server and as indicated. Install the Niagara Framework Engineering Tool on workstation hardware.

b. Monitoring and Control Software: Install the monitoring and control (M&C)software as shown. Except for M&C Software performing Point Calculations or Electrical Peak Demand Limiting, install M&C Software on server hardware. Install M&C Software performing Point Calculations or Electrical Peak Demand Limiting on either server hardware or Monitoring and Control (M&C) Controller Hardware.

   Provide sufficient computer hardware and M&C Controller Hardware and install M&C Software to support the number of points required in PART 2 (PRODUCTS), regardless of the number of points integrated under this project specification. Note that meeting this requirement may entail the installation of unused hardware or spare point licenses to accommodate the full number of required points in order to allow for integration of future field control systems.

c. M&C Controller Hardware Configuration Software: Install the M&C Controller Hardware Configuration Software on server hardware.

d. Operating system: Install the OS on each Server and Workstation and configure user names and passwords. Coordinate with the Facilities Department for user names and passwords.

e. Office Automation Software: Install the office automation software on each server and workstation.

f. Virus Protection software: Install the virus protection software on each server and workstation and configure weekly virus scans. Configure the virus protection software to update virus definitions automatically. Coordinate with the NEC to obtain update server information.

g. Disk Imaging (Backup) Software: Install the disk imaging (backup) software on each server and configure for imaging the internal hard drive to external hard drive.

Where software requires connection to an IP device outside of the UMCS, coordinate with the project site NEC to obtain access to a Government-furnished server to provide the needed functionality. Do not connect to any device outside of the UMCS without explicit permission from the project site NEC.

3.4.5.3 Monitoring and Control (M&C) Software Configuration

Configure the Monitoring and Control (M&C) Software as specified, as indicated and as follows:

a. Set up M&C Software user accounts and passwords. Coordinate user accounts, passwords and permissions with the Controls, HVAC and Electrical shop supervisor.

b. Change the default password on all accounts. Remove or disable any accounts which do not require authentication (such as guest accounts).

c. Configure e-mail capability to use a Government furnished SMTP server. Coordinate with the project site NEC for SMTP server information.

d. Disable all ports, protocols, and network services other than those required or specifically permitted by this Section. Services to be disabled include but are not limited to: FTP, Telnet and SSH.

e. Install web server certificate. Obtain certificate from the project site NEC.

3.4.5.4 Control Hardware Installation

Install Control Hardware in a lockable enclosure and as specified. Configure Control Hardware as specified, as required to meet the functions for which the hardware is used and as follows:

a. Disable all ports, protocols, and network services other than those required or specifically permitted by this Section. Services to be disabled include but are not limited to: FTP, Telnet, SSH, and HTTP except for HTTP originating in Niagara Framework Supervisory Gateways. When disabling of ports, protocols and services is not supported by a product, obtain an exception from this requirement prior to using the

product and document non-compliance on the Product Data Sheets and As-Built drawings.

b. Change the default passwords in all Control Hardware which have passwords. Coordinate new passwords with the Controls, HVAC and Electrical shop supervisor.

3.5 INTEGRATION OF FIELD CONTROL SYSTEMS

Fully integrate the field control systems in accordance with the following three step sequence and as specified and shown.

STEP 1: Install and configure Control Hardware as necessary to connect the field control system to the FPOC, which is part of the UMCS IP network, and to provide control protocol translation and supervisory functionality.

STEP 2: Add Field Control System to M&C Software: Perform system discovery, system database merges, or any other actions necessary to allow M&C Software access to the field control system.

STEP 3: Configure M&C Software to provide monitoring and control of the field control system, including but not limited to the creation of system displays and the configuration of scheduling, alarming, and trending.

3.5.1 Integration Step 1: Install Control Hardware

Install Control Hardware as specified at the FPOC location to connect the field control system to the UMCS IP network via the FPOC and, if necessary, to provide control protocol translation and supervisory functionality. Coordinate all connections and other activities related to an FPOC with the Facilities Department. Depending on the field control system media and protocol this must be accomplished through one of the following:

a. Connect the existing field control network hardware at the FPOC location to the FPOC.

b. Install a Niagara Framework Supervisory Gateway connected to both the field control network and the FPOC.

3.5.1.1 Installation of Niagara Framework Supervisory Gateway

Install Niagara Framework Supervisory Gateway hardware to connect the field control network to the FPOC. Install additional field control system network media and hardware as needed to connect the Niagara Framework Supervisory Gateway to the field control system.

3.5.2 Integration Step 2: Add Field Control System to M&C Software

Perform system discovery, system database merges, or any other actions necessary to allow M&C Software access to points and data in the field control system.

3.5.2.1 Integration of Field Control Systems Via Niagara Framework

For each Niagara Framework Supervisory Gateway installed in integration step 1 for this project do both of the following:

a. Use the Niagara Framework Engineering Tool to fully discover the field control system and make all field control system information available to the Niagara Framework Supervisory Gateway.

b. Create and configure points and establish network communication between the Niagara Framework Supervisory Gateway and the field control system to provide points from the field control system to the M&C software and to provide support for supervisory functions, including but not limited to schedule objects, trend logs and alarming.

For each Niagara Framework Supervisory Gateway to be integrated as part of this project, make all information in the Niagara Framework Supervisory Gateway available to the M&C Software.

3.5.3 Integration Step 3: Configure M&C Software

Configure M&C Software to provide monitoring and control of the field control system, including but not limited to the creation of system displays and the configuration of scheduling, alarming, and trending.

3.5.3.1 Configure M&C Software Communication

Create and configure points and establish network communication between M&C Software and Field Control Systems as specified to support M&C Software functionality:

a. Update points on currently active displays via polling as necessary to meet M&C Software display refresh requirements.

b. Send points used for overrides to the device receiving the override as shown on the Points Schedule.

Edit the Description field of each point to include the Real Property Unique IDs (RPUID) associated with that point as shown on the Points Schedule

3.5.3.2 Configure M&C Software Functionality

Fully configure M&C Software functionality using the M&C Software capabilities specified in PART 2 of this Section.

a. Create System Displays using the project site sample displays, including overrides, as shown on the Points Schedule and as specified. Label all points on displays with full English language descriptions. Configure user permissions for access to and executions of action using graphic pages. Coordinate user permissions with the Controls, HVAC and Electrical shop supervisors.

b. Configure alarm handling as shown on the Points Schedule, as shown on the Alarm Routing Schedule, and as specified. For alarms requiring notification via text message or e-mail, configure the alarm notification to use the specified Government furnished SMTP server to send the alarm notification.

c. Configure scheduling as indicated and as shown on the points schedule.

Create and configure displays for configuration of Schedule Objects in

the field control system. Label schedules and scheduled points with full English-language descriptors. Provide a separate configuration capability for each schedule. A single configuration display may be used to configured multiple schedules, provided that each schedule is separately configurable from the display.

d. Trend points at 15 minute intervals.

Create and configure displays for creation and configuration of trends and for display of all trended points.

e. Configure Demand Limiting as shown on the Demand Limit Schedule and Points Schedule and as specified.

f. Configure M&C Software standard reports.

3.6 START-UP AND START-UP TESTING

Test all equipment and perform all other tests necessary to ensure the system is installed and functioning as specified. Prepare a Start-Up and Start-Up Testing Report documenting all tests performed and their results and certifying that the system meets the requirements specified in the contract documents.

3.7 PERFORMANCE VERIFICATION TEST (PVT)

3.7.1 PVT Phase I Procedures

Provide PVT Procedures which include:.

a. Network bandwidth usage and available bandwidth (throughput) measurements. Network bandwidth usage must reference the normal usage network Bandwidth Calculations.

b. Test System Reaction during PVT: The total system response time from initiation of a control action command from the workstation, to display of the resulting status change on the workstation must not exceed 20 seconds under system normal heavy load conditions assuming a zero response time for operation of the node's control device.

c. Verification of IP Connectivity.

d. Verification of configuration of M&C Software functionality.

3.7.2 PVT Phase I

Demonstrate compliance of the control system with the contract documents. Using test plans and procedures previously approved by the Government, demonstrate all physical and functional requirements of the project. Upon completion of PVT Phase I and as specified, prepare and submit the PVT Phase I Report documenting all tests performed during the PVT and their results. In the PVT report, include all tests in the PVT Procedures and any other testing performed during the PVT. Document failures and repairs with test results.

3.7.3 PVT Phase II

Include Basic Training as part of PVT Phase II. Failures or deficiencies of the UMCS during Basic Training are considered PVT failures. Upon

completion of PVT Phase II, and as specified, prepare and submit the PVT Phase II Report documenting any failures which occurred and repairs performed during PVT Phase II.

3.8 MAINTENANCE AND SERVICE

Perform inspection, testing, cleaning, and part or component replacement as specified and as required to maintain the warranty. Work includes providing necessary preventive and unscheduled maintenance and repairs to keep the UMCS operating as specified, and accepted by the Government, and other services as specified. Perform work in compliance with manufacturer's recommendations and industry standards. Provide technical support via telephone during regular working hours.

3.8.1 Work Coordination

Schedule and arrange work to cause the least interference with the normal Government business and mission. In those cases where some interference may be essentially unavoidable, coordinate with the Government to minimize the impact of the interference, inconvenience, equipment downtime, interrupted service and personnel discomfort.

3.8.2 Work Control

Upon completion of work on a system or piece of equipment, that system or piece of equipment must be free of missing components or defects which would prevent it from functioning as originally intended and designed. Replacements must conform to the same specifications as the original equipment. During and at completion of work, do not allow debris to spread unnecessarily into adjacent areas nor accumulate in the work area itself.

3.8.3 Working Hours

Working hours are from 7:30 A.M. to 4:00 P.M. local time Mondays through Fridays except Federal holidays.

3.8.4 Equipment Repairs

Initiate and complete equipment repairs within the following time periods, where time periods are measured as actual elapsed time from first notification, including working and non-working hours:

a. for non-redundant computer server hardware, initiate within 4 hours and complete within 8 hours.

b. for non-redundant computer workstation hardware, initiate within 4 hours and complete within 8 hours.

c. for redundant computer server hardware, initiate within 36 hours and complete within 5 days.

d. for redundant computer workstation hardware, initiate within 2 days and complete within 5 days.

e. for active (powered) control hardware, initiate within 4 hours and complete within 6 hours.

f. for cabling and other passive network hardware, initiate within 16

hours and complete within 5 days.

Repair is the restoration of a piece of equipment, a system, or a facility to such condition that it may be effectively used for its designated purposes. Repair may be overhaul, reprocessing, or replacement of nonfunctional parts or materials or replacement of the entire unit or system.

3.8.5 Replacement, Modernization, Renovation

The Government may replace, renovate, or install new equipment as part of the UMCS at Government expense and by means not associated with this contract without voiding the system warranty. Replaced, improved, updated, modernized, or renovated systems and equipment interfaced to the system may be added to the Contractor's maintenance and service effort as a modification.

3.8.6 Access To UMCS Equipment

Access to UMCS equipment must be in accordance with the following:

a. Coordinate access to facilities and arrange that they be opened and closed during and after the accomplishment of the work effort. For access to a controlled facility contact the Government for assistance.

b. The Government may provide keys for access to UMCS equipment where the Government determines such key issuance is appropriate. Establish and implement methods of ensuring that keys issued by the Government are not lost or misplaced, are not used by unauthorized persons, and are not duplicated.

c. The Government may provide passwords or issue Common Access Cards (CAC) for access to UMCS computer equipment where the Government determines such issuance is appropriate. Establish and implement methods of ensuring that passwords and Common Access Cards issued by the Government are not used by unauthorized persons.

3.8.7 Records, Logs, and Progress Reports

Keep records and logs of each task, and organize cumulative chronological records for each major component, and for the complete system. Maintain a continuous log for the UMCS. Keep complete logs and be available for inspection on site, demonstrating that planned and systematic adjustments and repairs have been accomplished for the UMCS.

3.8.8 Preventive Maintenance Requirements

Perform maintenance procedures as described below, or more often if required by the equipment manufacturer.

3.8.8.1 Preventive Maintenance Work Plan

Prepare a Preventive Maintenance Work Plan detailing all required preventive maintenance. Obtain Government approval of the Work Plan as specified in paragraph PROJECT SEQUENCING. Strictly adhere to the approved work plan to facilitate Government verification of work.

3.8.8.2 Maintenance Procedures

3.8.8.2.1 Maintenance Coordination

Coordinate any scheduled maintenance event that may result in component downtime with the Government as follows, where time periods are measured as actual elapsed time from beginning of equipment off-line period, including working and non-working hours:

a. For non-redundant computer server hardware, provide 14 days notice, components must be off-line for no more than 8 hours.

b. For non-redundant computer workstation hardware, provide 7 days notice, components must be off-line for no more than 8 hours.

c. for redundant computer server hardware, provide 7 days notice, components must be off-line for no more than 36 hours.

d. For redundant computer workstation hardware, provide 4 days notice, components must be off-line for no more than 48 hours.

e. For active (powered) control hardware, provide 14 days notice, components must be off-line for no more than 6 hours.

f. For cabling and other passive network hardware, provide 21 days notice, components must be off-line for no more than 12 hours.

3.8.8.2.2 Software/Firmware

Software/firmware maintenance includes operating systems, application programs, and files required for the proper operation of the UMCS regardless of storage medium. User (project site) developed software is not covered by this contract, except that the UMCS software/firmware must be maintained to allow user creation, modification, deletion, and proper execution of such user-developed software as specified. Perform diagnostics and corrective reprogramming as required to maintain total UMCS operations as specified. Back up software before performing any computer hardware and software maintenance. Do not modify any parameters without approval from the Government. Properly document any approved changes and additions, and update the appropriate manuals.

3.8.8.2.3 Network

Network maintenance includes testing transmission media and equipment to verify signal levels, system data rates, errors and overall system performance.

3.8.9 Service Call Reception

a. A Government representative will advise the Contractor by phone or in person of all maintenance and service requests, as well as the classification of each based on the definitions specified. A description of the problem or requested work, date and time notified, location, classification, and other appropriate information will be placed on a Service Call Work Authorization Form by the Government.

b. Submit procedures for receiving and responding to service calls 24 hours per day, seven days a week, including weekends and holidays. Provide a single telephone number for receipt of service calls during

regular working hours; service calls are to be considered received at the time and date the telephone call is placed by the authorized Government representative.

c. Separately record each service call request, as received on the Service Call Work Authorization form and complete the Service Call Work Authorization form for each service call. Include the following information in the completed form: the serial number identifying the component involved, its location, date and time the call was received, nature of trouble, names of the service personnel assigned to the task, instructions describing what has to be done, the amount and nature of the materials to be used, the time and date work started, and the time and date of completion.

d. Respond to each service call request within two working hours. Provide the status of any item of work within four hours of the inquiry during regular working hours, and within 16 hours after regular working hours or as needed to meet the Equipment Repair requirements as specified.

3.8.10 Service Call Work Warranty

Provide a 1 year unconditional warranty on service call work which includes labor and material necessary to restore the equipment involved in the initial service call to a fully operable condition. In the event that service call work causes damage to additional equipment, restore the system to full operation without cost to the Government. Provide response times for service call warranty work equivalent to the response times required by the initial service call.

3.8.11 System Modifications

Make recommendations for system modification in writing to the Government. Do not make system modifications without prior approval of the Government. Incorporate any modifications made to the system into the Operations and Maintenance Instructions, and any other documentation affected. Make available to the Government software updates for all software furnished under this specification during the life of this contract. Schedule at least one update near the end of the contract period, at which time make available the latest released version of all software provided under this specification, and install and validate it upon approval by the Government.

3.9 TRAINING

Conduct training courses for designated personnel in the maintenance, service, and operation of the system as specified, including specified hardware and software. The training must be oriented to the specific system provided under this contract. Provide audiovisual equipment and other training material and supplies required for the training. When training is conducted at Government facilities, the Government reserves the right to record the training sessions for later use. A training day is defined as 8 hours of classroom instruction, excluding lunchtime, Monday through Friday, during the daytime shift in effect at the training facility. For guidance in planning the required instruction, the Contractor should assume that attendees will be tradesmen such as electricians or boiler operators. Obtain approval of the training schedule from the Government at least 30 days prior to the first day of training.

3.9.1 Training Documentation

Prepare and submit one set of Training manuals for each of Basic Training Documentation, Advanced Training Documentation, and Refresher Training Documentation, where each set of documentation consists of:

3.9.1.1 Course Attendance List

Course Attendance List developed in coordination with and signed by the Controls, HVAC and Electrical shop supervisor.

3.9.1.2 Training Manuals

Include an agenda, defined objectives for each lesson, and a detailed description of the subject matter for each lesson in the training manuals. Where portions of the course material are presented by audiovisuals, include copies of those audiovisuals as a part of the printed training manuals.

3.9.2 Basic Training

Conduct a Basic Training course at the project site on the installed system for a period of no less than 5 training days during Phase 2 of the PVT. A maximum of ten personnel will attend this course. Design training targeted towards training personnel in the day-to-day operation and basic maintenance of the system. Upon completion of this course, each student, using appropriate documentation, should be able to start the system, operate the system, recover the system after a failure, perform routine maintenance and describe the specific hardware architecture and operation of the system. Include the following topics at a minimum:

a. General system architecture.

b. Functional operation of the system, including workstations and system navigation.

c. System start-up procedures.

d. Failure recovery procedures.

e. Schedule configuration.

f. Trend configuration.

g. Perform point overrides and override release.

h. Reports generation.

i. Alarm reporting and acknowledgements.

j. Diagnostics.

k. Historical files.

l. Maintenance procedures:

(1) Physical layout of each piece of hardware.

(2) Troubleshooting and diagnostic procedures.

(3) Preventive maintenance procedures and schedules.

3.9.3 Advanced Training

Conduct an Advanced Operator Training course off-site or at the project site for a period of not less then five days. A maximum of ten personnel will attend this course. Structure the course to consist of "hands-on" training under the constant monitoring of the instructor. Include training on the M&C Software, and the Niagara Framework Engineering Tool. Upon completion of this course, the students should be fully proficient in the operation and management of all system operations and must be able to perform all tasks required to integrate a field control system into the UMCS. Report the skill level of each student at the end of this course. Include the following topics at a minimum:

a. A review of all topics in Basic Training

b. Using the

c. M&C Software configuration, including but not limited to: creating and editing system displays, alarms, schedules, trends, demand limiting and calculations.

3.9.4 Refresher Training

Conduct a Refresher Training course at the project site for a period of two training days when approved by the Government and as specified in paragraph PROJECT SEQUENCING. A maximum of ten personnel will attend the course. Structure the course to address specific topics that the students need to discuss and to answer questions concerning the operation of the system. Upon completion of the course, the students should be fully proficient in system operation and have no unanswered questions regarding operation of the installed UMCS. Correct any system failures discovered during the Refresher Training at no cost to the Government.

APPENDIX A

QC CHECKLIST			
This checklist is not all-inclusive of the requirements of this specification and should not be interpreted as such.			
This checklist is for (check one:)			
	Pre-Construction QC Checklist Submittal (Items 1-2)		( )
	Post-Construction QC Checklist Submittal (Items 1-6)		( )
	Close-out QC Checklist Submittal (Items 1-14)		( )
Instructions: Initial each item in the space provided (|____|) verifying that the requirement has been met.			
Verify the following items for Pre-Construction, Post-Construction and Closeout QC Checklist Submittals:			
1	Contractor Design Drawing Riser Diagram includes location and types of all Control Hardware and Computer Hardware.		|____|
2	M&C Software supports the Niagara Framework~~M&C Software supports the Niagara Framework~~ .		|____|
Verify the following items for Post-Construction and Closeout QC Checklist Submittal:			
3	Communication between the M&C Software and Niagara Framework field control systems uses only Fox protocol.		|____|
4	Connections to field control systems are via Niagara Framework Supervisory Gateways.		|____|
5	Computer workstations and servers are installed as shown on the UMCS Riser Diagram.		|____|

	QC CHECKLIST		
6	Training schedule and course attendee lists have been developed and coordinated with shops and submitted.		|____|
Verify the following items for Closeout QC Checklists Submittal:			
7	All points in field control systems have been discovered using the Niagara Framework Engineering Tool and are available at the M&C Software.		|____|
8	All software has been licensed to the Government.		|____|
9	M&C software monitoring displays have been created for all building systems, including all override and display points indicated on Points Schedule drawings.		|____|
10	Final As-built Drawings accurately represent the final installed system.		|____|
11	Default trends have been set up (per Points Schedule drawings).		|____|
12	Scheduling has been configured at the M&C Software (per Occupancy Schedule drawing).		|____|
13	O&M Instructions have been completed and submitted.		|____|
14	Basic Operator and Advanced Training courses have been completed.		|____|
_____ _____			
	(QC Representative Signature) (Date)		

-- End of Section --

SECTION 32 92 19

SEEDING
08/17

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C602	(2013a) Agricultural Liming Materials
ASTM D4427	(2013; R 2017) Standard Classification of Peat Samples by Laboratory Testing
ASTM D4972	(2013) pH of Soils

U.S. DEPARTMENT OF AGRICULTURE (USDA)

AMS Seed Act	(1940; R 1988; R 1998) Federal Seed Act
DOA SSIR 42	(1996) Soil Survey Investigation Report No. 42, Soil Survey Laboratory Methods Manual, Version 3.0

1.2 DEFINITIONS

1.2.1 Stand of Turf

95 percent ground cover of the established species.

1.3 RELATED REQUIREMENTS

Section 31 00 00 EARTHWORK, Section 32 92 23 SODDING, Section 32 93 00 EXTERIOR PLANTS~~, and Section 32 05 33 LANDSCAPE ESTABLISHMENT~~ applies to this section for pesticide use and plant establishment requirements, with additions and modifications herein.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance with Section 01 33 29 SUSTAINABILITY REPORTING. Submittals with an "AE" are for submittal to the Designer of Record. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Wood Cellulose Fiber Mulch; G, RO

Fertilizer; G, RO

Include physical characteristics, and recommendations.

SD-06 Test Reports

Topsoil Composition Tests; G, RO (reports and recommendations).

SD-07 Certificates

State Certification and Approval for Seed; G, RO

SD-08 Manufacturer's Instructions

Erosion Control Materials; G, RO

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Delivery

1.5.1.1 Seed Protection

Protect from drying out and from contamination during delivery, on-site storage, and handling.

1.5.1.2 Fertilizer Delivery

Deliver to the site in original, unopened containers bearing manufacturer's chemical analysis, name, trade name, trademark, and indication of conformance to state and federal laws. Instead of containers, fertilizer may be furnished in bulk with certificate indicating the above information.

1.5.2 Storage

1.5.2.1 Seed, Fertilizer Storage

Store in cool, dry locations away from contaminants.

1.5.2.2 Topsoil

Prior to stockpiling onsite topsoil, treat growing vegetation with application of appropriate specified non-selective herbicide. Clear and grub existing vegetation four to five weeks prior to stockpiling topsoil.

1.5.2.3 Handling

Do not drop or dump materials from vehicles.

1.6 TIME RESTRICTIONS AND PLANTING CONDITIONS

1.6.1 Restrictions

Do not plant when the ground is frozen, snow covered, muddy, or when air temperature exceeds 90 degrees Fahrenheit.

1.7 TIME LIMITATIONS

1.7.1 Seed

Apply seed within twenty four hours after seed bed preparation.

PART 2 PRODUCTS

2.1 SEED

2.1.1 Classification

Provide State-certified Endophyte-enhanced seed of the latest season's crop delivered in original sealed packages, bearing producer's guaranteed analysis for percentages of mixtures, purity, germination, weedseed content, and inert material. Label in conformance with AMS Seed Act and applicable state seed laws. Wet, moldy, or otherwise damaged seed will be rejected. Field mixes will be acceptable when field mix is performed on site in the presence of the Contracting Officer .

2.1.2 Planting Dates

Planting Season	Planting Dates
Season 1	April 1 to June 1
Season 2	Sept 1 to Oct 30

2.1.3 Seed Mixture by Weight

For areas on plans labeled as "fes var"	
Variety	Percent (by Weight)
Fine Fescue	80%
Kentucky Bluegrass	20%

2.2 TOPSOIL

2.2.1 On-Site Topsoil

Surface soil stripped and stockpiled on site and modified as necessary to meet the requirements specified for topsoil in paragraph COMPOSITION. When available topsoil must be existing surface soil stripped and stockpiled on-site in accordance with Section 31 00 00 EARTHWORK.

2.2.2 Off-Site Topsoil

Conform to requirements specified in paragraph COMPOSITION. Additional topsoil required for planting operations must be furnished by the Contractor.

2.2.3 Composition

Containing from 5 to 10 percent organic matter as determined by the topsoil composition tests of the Organic Carbon, 6A, Chemical Analysis Method described in DOA SSIR 42. Maximum particle size, 3/4 inch, with maximum 3 percent retained on 1/4 inch screen. The pH must be tested in accordance with ASTM D4972. Topsoil must be free of sticks, stones, roots, and other debris and objectionable materials. Other components must conform to the following limits:

Silt	20-30 percent
Clay	10-20 percent
Sand	50-60 percent
pH	6.0 to 7.0
Soluble Salts	600 ppm maximum

2.3 SOIL CONDITIONERS

Add conditioners to topsoil as required to bring into compliance with "composition" standard for topsoil as specified herein.

2.3.1 Lime

Commercial grade powdered limestone containing a calcium carbonate equivalent (C.C.E.) as specified in ASTM C602 of not less than 45 percent.

2.3.2 Aluminum Sulfate

Commercial grade.

2.3.3 Sulfur

100 percent elemental

2.3.4 Iron

100 percent elemental

2.3.5 Peat

Natural product of peat moss derived from a freshwater site and conforming to ASTM D4427. Shred and granulate peat to pass a 1/2 inch mesh screen and condition in storage pile for minimum 6 months after excavation.

2.3.6 Sand

Clean and free of materials harmful to plants.

2.3.7 Perlite

Horticultural grade.

2.3.8 Composted Derivatives

Ground bark, nitrolized sawdust, humus or other green wood waste material free of stones, sticks, and soil stabilized with nitrogen and having the following properties:

2.3.8.1 Particle Size

Minimum percent by weight passing:

No. 4 mesh screen	95
No. 8 mesh screen	80

2.3.8.2 Nitrogen Content

Minimum percent based on dry weight:

Fir Sawdust	0.7
Fir or Pine Bark	1.0

2.4 FERTILIZER

2.4.1 Granular Fertilizer

Organic, granular controlled release fertilizer containing the following minimum percentages, by weight, of plant food nutrients:

20 percent available nitrogen
5 percent available phosphorus
10 percent available potassium

2.4.2 Hydroseeding Fertilizer

Controlled release fertilizer, to use with hydroseeding and composed of pills coated with plastic resin to provide a continuous release of nutrients for at least 6 months and containing the following minimum percentages, by weight, of plant food nutrients.

15 percent available nitrogen
30 percent available phosphorus
15 percent available potassium

2.5 MULCH

Mulch must be free from noxious weeds, mold, and other deleterious materials.

2.5.1 Straw

Stalks from oats, wheat, rye, barley, or rice. Furnish in air-dry condition and of proper consistency for placing with commercial mulch blowing equipment. Straw must contain no fertile seed.

2.5.2 Hay

Air-dry condition and of proper consistency for placing with commercial mulch blowing equipment. Hay must be sterile, containing no fertile seed.

2.5.3 Wood Cellulose Fiber Mulch

Use recovered materials of either paper-based (100 percent post-consumer content) or wood-based (100 percent total recovered content) hydraulic mulch. Processed to contain no growth or germination-inhibiting factors and dyed an appropriate color to facilitate visual metering of materials application. Composition on air-dry weight basis: 9 to 15 percent moisture, pH range from 5.5 to 8.2. Use with hydraulic application of grass seed and fertilizer.

2.6 WATER

Source of water must be approved by Contracting Officer and of suitable quality for irrigation, containing no elements toxic to plant life.

2.7 EROSION CONTROL MATERIALS

Erosion control material must conform to the following:

2.7.1 Erosion Control Blanket

70 percent agricultural straw/30 percent coconut fiber matrix stitched with a degradable nettings, designed to degrade within 12 months.

2.7.2 Erosion Control Fabric

Fabric must be knitted construction of polypropylene yarn with uniform mesh openings 3/4 to 1 inch square with strips of biodegradable paper. Filler paper strips must have a minimum life of 6 months.

2.7.3 Erosion Control Net

Net must be heavy, twisted jute mesh, weighing approximately 1.22 pounds per linear yard and 4 feet wide with mesh openings of approximately one inch square.

2.7.4 Hydrophilic Colloids

Hydrophilic colloids must be physiologically harmless to plant and animal life without phytotoxic agents. Colloids must be naturally occurring, silicate powder based, and must form a water insoluble membrane after curing. Colloids must resist mold growth.

2.7.5 Erosion Control Material Anchors

Erosion control anchors must be as recommended by the manufacturer.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 EXTENT OF WORK

Provide soil preparation prior to planting (including soil conditioners as required), fertilizing, seeding, and surface topdressing of all newly graded finished earth surfaces, unless indicated otherwise, and at all areas inside or outside the limits of construction that are disturbed by the Contractor's operations.

3.1.1.1 Topsoil

Provide 4 inches of off-site topsoil or on-site topsoil to meet indicated finish grade. After areas have been brought to indicated finish grade, incorporate fertilizer, pH adjusters, and soil conditioners into soil a minimum depth of 4 inches by disking, harrowing, tilling or other method approved by the Contracting Officer. Remove debris and stones larger than 3/4 inch in any dimension remaining on the surface after finish grading. Correct irregularities in finish surfaces to eliminate depressions. Protect finished topsoil areas from damage by vehicular or pedestrian traffic.

3.1.1.2 Soil Conditioner Application Rates

Apply soil conditioners at rates as determined by laboratory soil analysis of the soils at the job site. For bidding purposes only apply at rates for the following:

Lime 25 pounds per 1000 square feet.

Sulfur 10 pounds per 1000 square feet.

Iron 12 pounds per 1000 square feet.

Aluminum Sulfate 50 pounds per 1000 square feet.

Peat 200 pounds per acre.

Sand 20 pounds per 1000 square feet.

Perlite 1.5 cubic yards per 1000 square feet.

Compost Derivatives 270 cubic yard per acre.

3.1.1.3 Fertilizer Application Rates

Apply fertilizer at rates as determined by laboratory soil analysis of the soils at the job site. For bidding purposes only apply at rates for the following:

Organic Granular Fertilizer 250 pounds per acre.

Hydroseeding Fertilizer 300 pounds per acre.

3.2 SEEDING

3.2.1 Seed Application Seasons and Conditions

Immediately before seeding, restore soil to proper grade. Do not seed outside of specified dates in sub-section 2.1.2, or when ground is muddy, frozen, snow covered, or in an unsatisfactory condition for seeding. If special conditions exist that may warrant a variance in the above seeding dates or conditions, submit a written request to the Contracting Officer stating the special conditions and proposed variance. Apply seed within twenty four hours after seedbed preparation. Sow seed by approved sowing equipment. Sow one-half the seed in one direction, and sow remainder at right angles to the first sowing.

3.2.2 Seed Application Method

The seeding method preferred for this project is hydroseeding. However, where grassed areas are too small for effective hydroseeding, as approved by the Contracting officer broadcast seeding methods may be utilized.

3.2.2.1 Broadcast and Drop Seeding

Seed must be uniformly broadcast at the rate of 5.0 pounds per 1000 square feet. Use broadcast or drop seeders. Sow one-half the seed in one direction, and sow remainder at right angles to the first sowing. Cover seed uniformly to a maximum depth of 1/4 inch in clay soils and 1/2 inch in sandy soils by means of spike-tooth harrow, cultipacker, raking or other approved devices.

3.2.2.2 Hydroseeding

First, mix water and fiber. Wood cellulose fiber, paper fiber, or recycled paper must be applied as part of the hydroseeding operation. Fiber must be added at 1,000 pounds, dry weight, per acre. Then add and mix seed and fertilizer to produce a homogeneous slurry. Seed must be mixed to ensure broadcasting at the rate of 5.0 pounds per 1000 square feet. When hydraulically sprayed on the ground, material must form a blotter like cover impregnated uniformly with grass seed. Spread with one application with no second application of mulch.

3.2.3 Mulching

3.2.3.1 Hay or Straw Mulch

Hay or straw mulch must be spread uniformly at the rate of 2 tons per acre. Mulch must be spread by hand, blower-type mulch spreader, or other approved method. Mulching must be started on the windward side of relatively flat areas or on the upper part of steep slopes, and continued uniformly until the area is covered. The mulch must not be bunched or clumped. Sunlight must not be completely excluded from penetrating to the ground surface. All areas installed with seed must be mulched on the same day as the seeding. Mulch must be anchored immediately following spreading.

3.2.3.2 Non-Asphaltic Tackifier

Hydrophilic colloid must be applied at the rate recommended by the manufacturer, using hydraulic equipment suitable for thoroughly mixing with water. A uniform mixture must be applied over the area.

3.2.4 Rolling

Immediately after broadcast seeding operations, firm entire area except for slopes in excess of 3 to 1 with a roller not exceeding 90 pounds for each foot of roller width. If seeding is performed with cultipacker-type seeder or by hydroseeding, rolling may be eliminated.

3.2.5 Erosion Control Material

Install in accordance with manufacturer's instructions, where indicated or as directed by the Contracting Officer.

3.2.6 Watering

Start watering areas seeded as required by temperature and wind conditions. Apply water at a rate sufficient to insure thorough wetting of soil to a depth of 1 inch per week without run off. During the germination process, seed is to be kept actively growing and not allowed to dry out.

3.3 PROTECTION OF TURF AREAS

Immediately after turfing, protect area against traffic and other use.

3.4 RESTORATION

Restore to original condition existing turf areas which have been damaged during turf installation operations at the Contractor's expense. Keep clean at all times at least one paved pedestrian access route and one paved vehicular access route to each building. Clean other paving when work in adjacent areas is complete.

-- End of Section --

SECTION 32 92 23

SODDING
04/06

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C602	(2013a) Agricultural Liming Materials
ASTM D4427	(2013; R 2017) Standard Classification of Peat Samples by Laboratory Testing
ASTM D4972	(2013) pH of Soils

TURFGRASS PRODUCERS INTERNATIONAL (TPI)

TPI GSS	(1995) Guideline Specifications to Turfgrass Sodding

U.S. DEPARTMENT OF AGRICULTURE (USDA)

DOA SSIR 42	(1996) Soil Survey Investigation Report No. 42, Soil Survey Laboratory Methods Manual, Version 3.0

1.2 DEFINITIONS

1.2.1 Stand of Turf

100 percent ground cover of the established species.

1.3 RELATED REQUIREMENTS

Section 31 00 00 EARTHWORK, Section 32 92 19 SEEDING, Section 32 93 00 EXTERIOR PLANTS~~, and Section 32 05 33 LANDSCAPE ESTABLISHMENT~~ applies to this section for pesticide use and plant establishment requirements, with additions and modifications herein.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submittals with an "AE" are for submittal to the Designer of Record. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Fertilizer; G, RO

Include physical characteristics, and recommendations.

SD-06 Test Reports

Topsoil composition tests; G, RO (reports and recommendations).

SD-07 Certificates

Sod farm certification for sods; G, RO. Indicate type of sod in accordance with TPI GSS.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Delivery

1.5.1.1 Sod Protection

Protect from drying out and from contamination during delivery, on-site storage, and handling.

1.5.1.2 Fertilizer and Lime Delivery

Deliver to the site in original, unopened containers bearing manufacturer's chemical analysis, name, trade name, trademark, and indication of conformance to state and federal laws. Instead of containers, fertilizer and lime may be furnished in bulk with certificate indicating the above information.

1.5.2 Storage

1.5.2.1 Sod Storage

Lightly sprinkle with water, cover with moist burlap, straw, or other approved covering; and protect from exposure to wind and direct sunlight until planted. Provide covering that will allow air to circulate so that internal heat will not develop. Do not store sod longer than 24 hours. Do not store directly on concrete or bituminous surfaces.

1.5.2.2 Topsoil

Prior to stockpiling onsite topsoil, treat growing vegetation with application of appropriate specified non-selective herbicide. Clear and grub existing vegetation five to six weeks prior to stockpiling topsoil.

1.5.2.3 Handling

Do not drop or dump materials from vehicles.

1.6 TIME RESTRICTIONS AND PLANTING CONDITIONS

1.6.1 Restrictions

Do not plant outside of specified dates in sub-section 2.1.3, or when the ground is frozen, snow covered, muddy, or when air temperature exceeds 90 degrees Fahrenheit.

1.7 TIME LIMITATIONS

1.7.1 Sod

Place sod a maximum of thirty six hours after initial harvesting, in accordance with TPI GSS as modified herein.

PART 2 PRODUCTS

2.1 SODS

2.1.1 Classification

Nursery grown, certified as classified in the TPI GSS. Machine cut sod at a uniform thickness of 3/4 inch within a tolerance of 1/4 inch, excluding top growth and thatch. Each individual sod piece shall be strong enough to support its own weight when lifted by the ends. Broken pads, irregularly shaped pieces, and torn or uneven ends will be rejected.

2.1.2 Purity

Sod species shall be genetically pure, free of weeds, pests, and disease.

2.1.3 Planting Dates

Lay sod from April 15 to June 15 for warm season spring planting and from Sept 1 to Oct 15 for cool season fall planting.

2.1.4 Composition

2.1.4.1 Proportion

Proportion grass species as follows.

Botanical Name	Common Name	Percent
Festuca spp.	Turf-type Tall Fescue	100

2.1.4.2 Sod Farm Overseeding

At the sod farm provide sod with overseeding of annual rye grass seed type recommended by seed producer.

2.2 TOPSOIL

2.2.1 On-Site Topsoil

Surface soil stripped and stockpiled on site and modified as necessary to meet the requirements specified for topsoil in paragraph entitled "Composition." When available topsoil shall be existing surface soil stripped and stockpiled on-site in accordance with Section 31 00 00 EARTHWORK.

2.2.2 Off-Site Topsoil

Conform to requirements specified in paragraph entitled "Composition."

Additional topsoil shall be furnished by the Contractor.

2.2.3 Composition

Containing from 5 to 10 percent organic matter as determined by the topsoil composition tests of the Organic Carbon, 6A, Chemical Analysis Method described in DOA SSIR 42. Maximum particle size, 3/4 inch, with maximum 3 percent retained on 1/4 inch screen. The pH shall be tested in accordance with ASTM D4972. Topsoil shall be free of sticks, stones, roots, and other debris and objectionable materials. Other components shall conform to the following limits:

Silt	20-30 percent
Clay	10-20 percent
Sand	50-60 percent
pH	6.0 to 7.0
Soluble Salts	600 ppm maximum

2.3 SOIL CONDITIONERS

Add conditioners to topsoil as required to bring into compliance with "composition" standard for topsoil as specified herein.

2.3.1 Lime

Commercial grade powdered limestone containing a calcium carbonate equivalent (C.C.E.) as specified in ASTM C602 of not less than 45 percent.

2.3.2 Aluminum Sulfate

Commercial grade.

2.3.3 Sulfur

100 percent elemental

2.3.4 Iron

100 percent elemental

2.3.5 Peat

Natural product of peat moss derived from a freshwater site and conforming to ASTM D4427. Shred and granulate peat to pass a 1/2 inch mesh screen and condition in storage pile for minimum 6 months after excavation.

2.3.6 Sand

Clean and free of materials harmful to plants.

2.3.7 Perlite

Horticultural grade.

2.3.8 Composted Derivatives

Ground bark, nitrolized sawdust, humus or other green wood waste material free of stones, sticks, and soil stabilized with nitrogen and having the following properties:

2.3.8.1 Particle Size

Minimum percent by weight passing:

No. 4 mesh screen	95
No. 8 mesh screen	80

2.3.8.2 Nitrogen Content

Minimum percent based on dry weight:

Fir Sawdust	0.7
Fir or Pine Bark	1.0

2.4 FERTILIZER

2.4.1 Granular Fertilizer

Organic, granular controlled release fertilizer containing the following minimum percentages, by weight, of plant food nutrients:

20 percent available nitrogen
5 percent available phosphorus
10 percent available potassium

2.5 WATER

Source of water shall be approved by Contracting Officer and of suitable quality for irrigation containing no element toxic to plant life.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 Extent Of Work

Provide soil preparation (including soil conditioners), fertilizing, and sodding of all newly graded finished earth surfaces, unless indicated otherwise, and at all areas inside or outside the limits of construction that are disturbed by the Contractor's operations.

3.1.2 Soil Preparation

Provide 4 inches of off-site topsoil or on-site topsoil to meet indicated finish grade. After areas have been brought to indicated finish grade, incorporate fertilizer, pH adjusters, and soil conditioners into soil a minimum depth of 4 inches by disking, harrowing, tilling or other method approved by the Contracting Officer. Remove debris and stones larger than 3/4 inch in any dimension remaining on the surface after finish grading.

Correct irregularities in finish surfaces to eliminate depressions. Protect finished topsoil areas from damage by vehicular or pedestrian traffic.

3.1.2.1 Soil Conditioner Application Rates

Apply soil conditioners at rates as determined by laboratory soil analysis of the soils at the job site. For bidding purposes only apply at rates for the following:

Lime 25 pounds per 1000 square feet.

Sulfur 10 pounds per 1000 square feet.

Iron 12 pounds per 1000 square feet.

Aluminum Sulfate 50 pounds per 1000 square feet.

Peat 200 pounds per acre.

Sand 20 pounds per 1000 square feet.

Perlite 1.5 cubic yards per 1000 square feet.

Compost Derivatives 270 cubic yard per acre.

3.1.2.2 Fertilizer Application Rates

Apply fertilizer at rates as determined by laboratory soil analysis of the soils at the job site. For bidding purposes only apply at rates for the following:

Organic Granular Fertilizer 250 pounds per acre.

3.2 SODDING

3.2.1 Finished Grade and Topsoil

Prior to the commencement of the sodding operation, the Contractor shall verify that finished grades are as indicated on drawings; the placing of topsoil, smooth grading, and compaction requirements have been completed in accordance with Section 31 00 00 EARTHWORK.

The prepared surface shall be a maximum 1 inch below the adjoining grade of any surfaced area. New surfaces shall be blended to existing areas. The prepared surface shall be completed with a light raking to remove from the surface debris and stones over a minimum 5/8 inch in any dimension.

3.2.2 Placing

Place sod a maximum of 36 hours after initial harvesting, in accordance with TPI GSS as modified herein.

3.2.3 Sodding Slopes and Ditches

For slopes 2:1 and greater, lay sod with long edge perpendicular to the contour. For V-ditches and flat bottomed ditches, lay sod with long edge perpendicular to flow of water.

3.2.4 Finishing

After completing sodding, blend edges of sodded area smoothly into surrounding area. Air pockets shall be eliminated and a true and even surface shall be provided. Frayed edges shall be trimmed and holes and missing corners shall be patched with sod.

3.2.5 Rolling

Immediately after sodding, firm entire area except for slopes in excess of 3 to 1 with a roller not exceeding 90 pounds for each foot of roller width.

3.2.6 Watering

Start watering areas sodded as required by daily temperature and wind conditions. Apply water at a rate sufficient to ensure thorough wetting of soil to minimum depth of 6 inches. Run-off, puddling, and wilting shall be prevented. Unless otherwise directed, watering trucks shall not be driven over turf areas. Watering of other adjacent areas or plant material shall be prevented.

3.3 PROTECTION OF TURF AREAS

Immediately after turfing, protect area against traffic and other use.

3.4 RESTORATION

Restore to original condition existing turf areas which have been damaged during turf installation operations. Keep clean at all times at least one paved pedestrian access route and one paved vehicular access route to each building. Clean other paving when work in adjacent areas is complete.

-- End of Section --

SECTION 32 93 00

EXTERIOR PLANTS
08/17

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICANHORT (AH)

ANSI/ANLA Z60.1	(2004) American Standard for Nursery Stock

ASTM INTERNATIONAL (ASTM)

ASTM A580/A580M	(2018) Standard Specification for Stainless Steel Wire
ASTM C602	(2013a) Agricultural Liming Materials
ASTM D4427	(2013; R 2017) Standard Classification of Peat Samples by Laboratory Testing
ASTM D4972	(2013) pH of Soils
ASTM D5268	(2013) Topsoil Used for Landscaping Purposes
ASTM D5852	(2000; R 2007; E 2014) Standard Test Method for Erodibility Determination of Soil in the Field or in the Laboratory by the Jet Index Method
ASTM D6155	(2015) Nontraditional Coarse Aggregate for Bituminous Paving Mixtures
ASTM D6629	(2001; E 2012; R 2012) Selection of Methods for Estimating Soil Loss by Erosion

L.H. BAILEY HORTORIUM (LHBH)

LHBH	(1976) Hortus Third

TREE CARE INDUSTRY ASSOCIATION (TCIA)

TCIA A300P1	(2017) ANSI A300 Part1: Tree Care Operations - Trees, Shrubs and Other Woody Plant Maintenance Standard Practices - Pruning
TCIA Z133	(2017) American National Standard for Arboricultural Operations - Pruning, Repairing, Maintaining, and Removing Trees, and Cutting Brush - Safety

Requirements

U.S. DEPARTMENT OF AGRICULTURE (USDA)

DOA SSIR 42 (1996) Soil Survey Investigation Report No. 42, Soil Survey Laboratory Methods Manual, Version 3.0

1.2 RELATED REQUIREMENTS

Section 31 00 00 EARTHWORK, Section 32 92 19 SEEDING, Section 32 92 23 SODDING~~, and Section 32 05 33 LANDSCAPE ESTABLISHMENT~~ applies to this section for pesticide use and plant establishment requirements, with additions and modifications herein.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance with Section 01 33 29 SUSTAINABILITY REPORTING. Submittals with an "AE" are for submittal to the Designer of Record. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

State Landscape Contractor's License

Time Restrictions and Planting Conditions

Indicate anticipated dates and locations for each type of planting.

SD-03 Product Data

Peat; G, RO

Composted Derivatives

Rotted Manure

Organic Mulch Materials; G, RO

Mulch; G, RO

Ground Stakes

Fertilizer; G, RO

Root Control Barrier; G, RO

Staking Material

Metal Anchors

Antidesiccants

Erosion Control Materials

Photographs; G, RO

SD-04 Samples

Mulch; G, RO

Submit one pint of mulch.

SD-06 Test Reports

Topsoil Composition Tests; G, RO; Soil Test of proposed area; Soil Test location map

Percolation Test; ; Percolation Test of proposed area

SD-07 Certificates

Nursery Certifications

SD-10 Operation and Maintenance Data

Plastic Identification

When not labeled, identify types in Operation and Maintenance Manual, with the use of photographs as necessary.

1.4 QUALITY ASSURANCE

1.4.1 Topsoil Composition Tests

Commercial test from an independent testing laboratory including basic soil groups (moisture and saturation percentages, Nitrogen-Phosphorus-Potassium (N-P-K) ratio, pH (ASTM D4972), soil salinity), secondary nutrient groups (calcium, magnesium, sodium, Sodium Absorption Ratio (SAR)), micronutrients (zinc, manganese, iron, copper), toxic soil elements (boron, chloride, sulfate), cation exchange and base saturation percentages, and soil amendment and fertilizer recommendations with quantities for plant material being transplanted. Soil required for each test must include a maximum depth of 18 inches of approximately one quart volume for each test. Areas sampled should not be larger than one acre and should contain at least 6-8 cores for each sample area and be thoroughly mixed. Problem areas should be sampled separately and compared with samples taken from adjacent non-problem areas. The location of the sample areas should be noted and marked on a parcel or planting map for future reference.

1.4.2 Nursery Certifications

a. Indicate on nursery letterhead the name of plants in accordance with the LHBH (LH Bailey Hortorium, 1976 Hortus, 3rd Edition), including botanical common names, quality, and size.

b. Inspection certificate.

c. Mycorrhizal fungi inoculum for plant material treated

1.4.3 State Landscape Contractor's License

Construction company must hold a landscape contractors license in the state where the work is performed and have a minimum of five years landscape construction experience. Submit copy of license and three references for similar work completed in the last five years.

1.4.4 Plant Material Photographs

Contractor must submit nursery photographs, for government approval prior to ordering, for each tree larger than 24-inch box/ 2-inch caliper size.

1.4.5 Percolation Test

Immediately following rough grading operation, identify a typical location for one of the largest trees and or shrubs and excavate a pit per the project details. Fill the pit with water to a depth of 12 inches. The length of time required for the water to percolate into the soil, leaving the pit empty, must be measured by the project Landscape Architect and verified by the Contracting Officer. Within six hours of the time the water has drained from the pit, the Contractor, with the Contracting Officer and project Landscape Architect present, must again fill the pit with water to a depth of 12 inches. If the water does not completely percolate into the soil within 9 hours, a determination must be made whether a drainage system or a soil penetrant will be required for each tree and or shrub being transplanted.

1.4.6 Erosion Assessment

Assess potential effects of soil management practices on soil loss in accordance with ASTM D6629. Assess erodibility of soil with dominant soil structure less than 2.8 to 3.1 inches in accordance with ASTM D5852.

1.4.7 Pre-Installation Meeting

Convene a pre-installation meeting a minimum of one week prior to commencing work of this section. Require attendance of parties directly affecting work of this section. Review conditions of operations, procedures and coordination with related work. Agenda must include the following:

a. Tour, inspect, and discuss conditions of planting materials.

b. Review planting schedule and maintenance, including phasing of installation if necessary.

c. Review required inspections.

d. Review environmental procedures.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Delivery

1.5.1.1 Branched Plant Delivery

Deliver with branches tied and exposed branches covered with material which allows air circulation. Prevent damage to branches, trunks, root systems, and root balls and desiccation of leaves.

1.5.1.2 Soil Amendment Delivery

Deliver to the site in original, unopened containers bearing manufacturer's chemical analysis, name, trade name, or trademark, and indication of conformance to state and federal laws. Instead of containers, fertilizer, and lime may be furnished in bulk with a certificate indicating the above information. Store in dry locations away from contaminates.

1.5.1.3 Plant Labels

Deliver plants with durable waterproof labels in weather-resistant ink. Provide labels stating the correct botanical and common plant name and variety as applicable and size as specified in the list of required plants. Attach to plants, bundles, and containers of plants. Groups of plants may be labeled by tagging one plant. Labels must be legible for a minimum of 60 days after delivery to the planting site.

1.5.2 Storage

1.5.2.1 Plant Storage and Protection

Store and protect plants not planted on the day of arrival at the site as follows:

a. Shade and protect plants in outside storage areas from the wind and direct sunlight until planted.

b. Heel-in bare root plants.

c. Protect balled and burlapped plants from freezing or drying out by covering the balls or roots with moist burlap, sawdust, wood chips, shredded bark, peat moss, or other approved material. Provide covering which allows air circulation.

d. Keep plants in a moist condition until planted by watering with a fine mist spray.

e. Do not store plant material directly on concrete or bituminous surfaces.

1.5.2.2 Fertilizer, pH Adjusters and Mulch Storage

Store in dry locations away from contaminants.

1.5.2.3 Topsoil

Prior to stockpiling onsite topsoil, eradicate on site undesirable growing vegetation. Clear and grub existing vegetation five to six weeks prior to stockpiling existing topsoil.

1.5.2.4 Root Control Barrier

Store materials on site in enclosures or under protective covering in dry location. Store under cover out of direct sunlight. Do not store materials directly on ground.

1.5.3 Handling

Do not drop or dump plants from vehicles. Avoid damaging plants being moved from nursery or storage area to planting site. Handle balled and burlapped in-ground fabric bag grown container plants carefully to avoid damaging or breaking the earth ball or root structure. Do not handle plants by the trunk or stem. Remove damaged plants from the site.

1.5.4 TIME LIMITATION

Except for container-grown plant material, the time limitation from digging to installing plant material must be a maximum of 90 days. The time limitation between installing the plant material and placing the mulch must be a maximum of 24 hours.

1.6 TIME RESTRICTIONS AND PLANTING CONDITIONS

Coordinate installation of planting materials during optimal planting seasons for each type of plant material required.

1.6.1 Planting Dates

1.6.1.1 Deciduous Material

Deciduous material from April 1 to June 1 for spring /summer planting and from Sept 1 to Nov 30 for fall planting.

1.6.1.2 Evergreen Material

Evergreen material from April 1 to June 1 for spring /summer planting and from Aug 15 to Oct 15 for fall planting.

1.6.2 Restrictions

Do not plant outside of specified Spring and Fall season dates as stated above, or when ground is frozen, snow covered, muddy, or when air temperature exceeds 90 degrees Fahrenheit

1.7 GUARANTEE

All plants must be guaranteed for one year beginning on the date of inspection and substantial completion by the Contracting Officer to commence the plant establishment period, against defects including death and unsatisfactory growth, except for defects resulting from lack of adequate maintenance, neglect, or abuse by the Government or by weather conditions unusual for the warranty period.

Remove and replace dead planting materials immediately unless required to plant in the succeeding planting season. At end of warranty period, replace planting materials that die or have 25 percent or more of their branches that die during the construction operations or the guarantee period.

1.8 PLASTIC IDENTIFICATION

Provide product data indicating polymeric information in Operation and Maintenance Manual.

Type 1: Polyethylene Terephthalate (PET, PETE).

Type 2: High Density Polyethylene (HDPE).
Type 3: Vinyl (Polyvinyl Chloride or PVC).
Type 4: Low Density Polyethylene (LDPE).
Type 5: Polypropylene (PP).
Type 6: Polystyrene (PS).
Type 7: Other. Use of this code indicates that the package in question is made with a resin other than the six listed above, or is made of more than one resin listed above, and used in a multi-layer combination.

PART 2 PRODUCTS

2.1 PLANTS

2.1.1 Regulations and Varieties

Existing trees and shrubs to remain must be protected and a planting plan be arranged around them. Furnish nursery stock in accordance with ANSI/ANLA Z60.1, except as otherwise specified or indicated. Each plant or group of planting must have a "key" number indicated on the nursery certifications of the plant schedule. Furnish plants, including turf grass, grown under climatic conditions similar to those in the locality of the project. Plants specified must be low maintenance varieties, tolerant of site's existing soils and climate without supplemental irrigation or fertilization once established. Spray plants budding into leaf or having soft growth with an antidesiccant before digging. Plants of the same specified size must be of uniform size and character of growth. Plants must be chosen with their mature size and growth habit in mind to avoid over-planting and conflict with other plants, structures or underground utility lines. All plants must comply with all Federal and State Laws requiring inspection for plant diseases and infestation.

2.1.2 Shape and Condition

Well-branched, well-formed, sound, vigorous, healthy planting stock free from disease, sunscald, windburn, abrasion, and harmful insects or insect eggs and having a healthy, normal, and undamaged root system.

2.1.2.1 Deciduous Trees and Shrubs

Symmetrically developed and of uniform habit of growth, with straight boles or stems, and free from objectionable disfigurements.

2.1.2.2 Evergreen Trees and Shrubs

Well developed symmetrical tops with typical spread of branches for each particular species or variety.

2.1.2.3 Ground Covers and Vines

Number and length of runners and clump sizes indicated, and of the proper age for the grade of plants indicated, furnished in removable containers, integral containers, or formed homogeneous soil section.

2.1.3 Plant Size

Minimum sizes measured after pruning and with branches in normal position, must conform to measurements indicated, based on the average width or height of the plant for the species as specified in ANSI/ANLA Z60.1.

Plants larger in size than specified may be provided with approval of the Contracting Officer. When larger plants are provided, increase the ball of earth or spread of roots in accordance with ANSI/ANLA Z60.1.

2.1.4 Root Ball Size

All box-grown, field potted, field boxed, collected, plantation grown, bare root, balled and burlapped, container grown, processed-balled, and in-ground fabric bag-grown root balls must conform to ANSI/ANLA Z60.1. All wrappings and ties must be biodegradable. Root growth in container grown plants must be sufficient to hold earth intact when removed from containers. Root bound plants will not be accepted.

2.1.4.1 Mycorrhizal fungi inoculum

Before shipment, root systems must contain mycorrhizal fungi inoculum.

2.1.5 Growth of Trunk and Crown

2.1.5.1 Deciduous Trees

A height to caliper relationship must be provided in accordance with ANSI/ANLA Z60.1. Height of branching must bear a relationship to the size and species of tree specified and with the crown in good balance with the trunk. The trees must not be "poled" or the leader removed.

a. Single stem: The trunk must be reasonably straight and symmetrical with crown and have a persistent main leader.

b. Multi-stem: All countable stems, in aggregate, must average the size specified. To be considered a stem, there must be no division of the trunk which branches more than 6 inches from ground level.

2.1.5.2 Deciduous Shrubs

Deciduous shrubs must have the height and number of primary stems recommended by ANSI/ANLA Z60.1. Acceptable plant material must be well shaped, with sufficient well-spaced side branches, and recognized by the trade as typical for the species grown in the region of the project.

2.1.5.3 Coniferous Evergreen Plant Material

Coniferous Evergreen plant material must have the height-to-spread ratio recommended by ANSI/ANLA Z60.1. The coniferous evergreen trees must not be "poled" or the leader removed. Acceptable plant material must be exceptionally heavy, well shaped and trimmed to form a symmetrical and tightly knit plant. The form of growth desired must be as indicated.

2.1.5.4 Broadleaf Evergreen Plant Material

Broadleaf evergreen plant material must have the height-to-spread ratio recommended by ANSI/ANLA Z60.1. Acceptable plant material must be well shaped and recognized by the trade as typical for the variety grown in the region of the project.

2.1.5.5 Ground Cover and Vine Plant Material

Ground cover and vine plant material must have the minimum number of runners and length of runner recommended by ANSI/ANLA Z60.1. Plant

material must have heavy, well developed and balanced crown with vigorous, well developed root system and must be furnished in containers.

2.2 TOPSOIL

2.2.1 Existing Soil

Existing soil may only be used when authorized by Contracting Officer. Modify to conform to requirements specified in paragraph COMPOSITION.

2.2.2 On-Site Topsoil

Surface soil stripped and stockpiled on site and modified as necessary to meet the requirements specified for topsoil in paragraph COMPOSITION. When available topsoil must be existing surface soil stripped and stockpiled on-site in accordance with Section 31 00 00 EARTHWORK.

2.2.3 Off-Site Topsoil

Conform to requirements specified in paragraph COMPOSITION. Additional topsoil must be furnished by the Contractor.

2.2.4 Composition

Evaluate soil for use as topsoil in accordance with ASTM D5268. From 5 to 10 percent organic matter as determined by the topsoil composition tests of the Organic Carbon, 6A, Chemical Analysis Method described in DOA SSIR 42. Maximum particle size, 3/4 inch, with maximum 3 percent retained on 1/4 inch screen. The pH must be tested in accordance with ASTM D4972. Topsoil must be free of sticks, stones, roots, plants, and other debris and objectionable materials. Other components must conform to the following limits:

Silt	20-30 percent
Clay	10-20 percent
Sand	50-60 percent
pH	6.0 to 7.0
Soluble Salts	600 ppm maximum

2.3 SOIL CONDITIONERS

Provide singly or in combination as required to meet specified requirements for topsoil. Soil conditioners must be nontoxic to plants.

2.3.1 Lime

Commercial grade hydrated or burnt limestone containing a calcium carbonate equivalent (C.C.E.) as specified in ASTM C602 of not less than 80 percent.

2.3.2 Aluminum Sulfate

Commercial grade.

2.3.3 Sulfur

100 percent elemental

2.3.4 Iron

100 percent elemental

2.3.5 Peat

Natural product of peat moss derived from a freshwater site and conforming to ASTM D4427 as modified herein. Shred and granulate peat to pass a 1/2 inch mesh screen and condition in storage pile for minimum 6 months after excavation. Peat must not contain invasive species, including seeds.

2.3.6 Sand

Clean and free of materials harmful to plants.

2.3.7 Perlite

Horticultural grade.

2.3.8 Composted Derivatives

Ground bark, nitrolized sawdust, humus or other green wood waste material free of stones, sticks, invasive species, including seeds, and soil stabilized with nitrogen and having the following properties:

2.3.8.1 Particle Size

Minimum percent by weight passing:

No. 4 mesh screen	95
No. 8 mesh screen	80

2.3.8.2 Nitrogen Content

Minimum percent based on dry weight:

Fir Sawdust	0.7
Fir or Pine Bark	1.0

2.3.9 Vermiculite

Horticultural grade for planters.

2.3.10 Rotted Manure

Well rotted horse or cattle manure containing maximum 25 percent by volume of straw, sawdust, or other bedding materials; free of seeds, stones, sticks, soil, and other invasive species.

2.4 PLANTING SOIL MIXTURES

Sandy topsoil: one part topsoil to one part peat. Thoroughly mix all parts of planting soil mixture to a uniform blend throughout.

2.5 FERTILIZER

Fertilizer for groundcover, wildflowers and wild grasses is not permitted. Fertilizer for trees, plants, and shrubs must be as recommended by plant supplier, except synthetic chemical fertilizers are not permitted. Fertilizers containing petrochemical additives or that have been treated with pesticides or herbicides are not permitted.

2.5.1 Granular Fertilizer

Organic, granular controlled release fertilizer containing the following minimum percentages, by weight, of plant food nutrients:

20 percent available nitrogen
5 percent available phosphorus
10 percent available potassium

2.5.2 Fertilizer Tablets

Organic, plant tablets composed of tightly compressed fertilizer chips forming a tablet that is insoluble in water, is designed to provide a continuous release of nutrients for at least 24 months and contains the following minimum percentages, by weight, of plant food nutrients:

20 percent available nitrogen
10 percent available phosphorus
5 percent available potassium

2.6 MULCH

Free from noxious weeds, mold, pesticides, or other deleterious materials.

2.6.1 Inert Mulch Materials

Provide river stone (smooth), complying with ASTM D6155, ranging in size from 2 to 4 inches with a varying color range from tan to grey.

2.6.2 Organic Mulch Materials

Provide wood chips, shredded hardwood, or recycled hardwood from site when available. Must be processed to contain no growth or germination-inhibiting factors, dyed with non-toxic, biodegradable dye to an appropriate color to facilitate visual metering of materials application. Wood-based hydraulic mulch must contain 100 percent total recovered materials content.

2.7 STAKING AND GUYING MATERIAL

2.7.1 Staking Material

2.7.1.1 Tree Support Stakes

Rough sawn hard wood free of knots, rot, cross grain, bark, long slivers, or other defects that impair strength. Stakes must be minimum 2 inches square or 2-1/2 inch diameter by 8 feet long, pointed at one end..

2.7.1.2 Ground Stakes

Rough sawn hard wood or plastic, 2 inches square are by 3 feet long,

pointed at one end.

2.7.2 Guying Material

2.7.2.1 Guying Wire

12 gauge annealed galvanized steel, ASTM A580/A580M.

2.7.2.2 Guying Cable

Minimum five-strand, 3/16 inch diameter galvanized steel cable plastic coated.

2.7.3 Hose Chafing Guards

New or used 2 ply 3/4 inch diameter reinforced rubber or plastic hose, black or dark green, all of same color.

2.7.4 Flags

White 1/2 inch diameter PVC pipe, 12 inches long, fastened to guying wires or cables.

2.7.5 Turnbuckles

Galvanized or cadmium-plated steel with minimum 3 inch long openings fitted with screw eyes. Eye bolts must be galvanized or cadmium-plated steel with one inch diameter eyes and screw length 1-1/2 inches, minimum.

2.7.6 Deadmen

4 by 8 inch rectangular or 8 inch diameter by 36 inch long, pine wood material.

2.7.7 Metal Anchors

2.7.7.1 Driven Anchors

Malleable iron, arrow shaped, galvanized, sized as follows:

Tree Caliper	Anchor Size
2 inches and under	3 inches
3 to 6 inches	4 inches
6 to 8 inches	6 inches
8 to 10 inches	8 inches
10 to 12 inches	10 inches

2.7.7.2 Screw Anchors

Steel, screw type with welded-on 3 inch round helical steel plate, minimum 3/8 inch diameter, 15 inches long.

2.8 ANTIDESICCANTS

Sprayable, water insoluble vinyl-vinledine complex which produce a moisture retarding barrier not removable by rain or snow. Film must form at temperatures commonly encountered out of doors during planting season and have a moisture vapor transmission rate (MVT) of the resultant film of maximum 10 grams per 24 hours at 70 percent humidity.

2.9 EROSION CONTROL MATERIALS

Erosion control material must conform to the following:

2.9.1 Erosion Control Blanket

100 percent agricultural straw stitched with a degradable nettings, designed to degrade within 12 months.

2.9.2 Erosion Control Fabric

Fabric must be knitted construction of polypropylene yarn with uniform mesh openings 3/4 to 1 inch square with strips of biodegradable paper. Filler paper strips must have a minimum life of 6 months.

2.9.3 Erosion Control Net

Net must be heavy, twisted jute mesh, weighing approximately 1.22 pounds per linear yard and 4 feet wide with mesh openings of approximately one inch square.

2.9.4 Hydrophilic Colloids

Hydrophilic colloids must be physiologically harmless to plant and animal life without phytotoxic agents. Colloids must be naturally occurring, silicate powder based, and must form a water insoluble membrane after curing. Colloids must resist mold growth.

2.9.5 Erosion Control Material Anchors

Erosion control anchors must be only as recommended by the manufacturer.

2.10 ROOT CONTROL BARRIER

Flexible and permeable geotextile fabric with permanently attached time-released nodules. Color to be black. Pre-formed, round, tapered cylinder barrier with integral vertical root deflecting ribs constructed of ultraviolet resistant polypropylene material. Color to be black .

2.11 PAVEMENT SUPPORT SYSTEM

a. A pavement support system designed specifically for the purpose of providing uncompacted soil for healthy tree growth and/or stormwater management (bioretention) under load-bearing pavement surfaces.

b. The pavement support system shall have the flexibly to be assembled around existing structures, utilities and in tight constraints, specific to the site requirements and achieve the required soil and/or stormwater volume. The system shall be easily disassembled and reassembled to allow for utility repair within and below the system.

c. The pavement support system is a complete system that includes but is not limited to the following integral components: SOIL MODULES, geogrid/geofabric, and root management products.

2.12 WATER

Source of water to be approved by Contracting Officer and suitable quality for irrigation and must not contain elements toxic to plant life, including acids, alkalis, salts, chemical pollutants, and organic matter. Use collected storm water or graywater when available.

2.13 MYCORRHIZAL FUNGI INOCULUM

Mycorrhizal fungi inoculum must be composed of multiple-fungus inoculum as recommended by the manufacturer for the plant material specified.

2.14 SOURCE QUALITY CONTROL

The Contracting Officer will inspect plant materials at the project site and approve them. Tag plant materials for size and quality.

PART 3 EXECUTION

3.1 EXTENT OF WORK

Provide soil preparation, including soil conditioners and soil amendments prior to planting. Provide tree, shrub, vine, groundcover, planting, post-planting fertilizer, edging, staking, guying, erosion control material, root control barrier installation, and mulch topdressing of all newly graded finished earth surfaces, unless indicated otherwise, and at all areas inside or outside the limits of construction that are disturbed by the Contractor's operations.

3.2 PAVEMENT SUPPORT SYSTEM INSTALLATION

a. Installation procedure, as follows, shall be followed by the Contractor. The Contractor shall also reference the Manufacturer's Installation Guidelines, and where any discrepancy exists the Consultant reserves the right to contact the Manufacturer's Representative prior to continuation. Installation constitutes acceptance of existing conditions and responsibility for satisfactory performance.

b. Install soil module panels in strict accordance with manufacturer's written instructions and installation diagrams. Prior to placement, check each soil module panel for damage. Reject cracked, chipped and otherwise damaged modules. Ensure that panels in contact with granular base course are firmly seated, with no rocking. Ensure that panels are mechanically interconnected both horizontally and, in multiple layers, vertically.

c. Upon completion of the soil module system, wrap the sides of the system with root and moisture barrier, or geogrid/fabric to prevent material migration into the PAVEMENT SUPPORT SYSTEM. Take great care to avoid damage to the root and moisture or geogrid/fabric barrier during placement. If damage occurs, repair that portion per manufacturer specifications.

3.3 ALTERNATIVE HERBICIDE TREATMENT (SOLARIZING SOIL)

Within 48 hours of subsoil preparation, saturate soil with water to a depth of 3 feet. Immediately stake polyethylene sheeting over area to be planted. Stake tightly to surface of soil. Maintain sheeting in place for a minimum of 6 weeks. Immediately after removing sheeting, cover area to be planted with topsoil. Do not till soil prior to applying topsoil.

3.4 PREPARATION

3.4.1 Protection

Protect existing and proposed landscape features, elements, and sites from damage or contamination. Protect trees, vegetation, and other designated features by erecting high-visibility, reusable construction fencing. Locate fence no closer to trees than the drip line. Plan equipment and vehicle access to minimize and confine soil disturbance and compaction to areas indicated on Drawings.

3.4.2 Layout

Stake out approved plant material locations and planter bed outlines on the project site before digging plant pits or beds. The Contracting Officer reserves the right to adjust plant material locations to meet field conditions. Do not plant closer than 24 inches to a building wall, pavement edge, fence or wall edge and other similar structures. Provide on-site locations for excavated rock, soil, and vegetation.

3.4.3 Erosion Control

Provide erosion control and seeding with native plant species to protect slopes.

3.4.4 Soil Preparation

3.4.4.1 pH Adjuster Application Rates

Apply pH adjuster at rates as determined by laboratory soil analysis of the soils at the job site. For bidding purposes only apply at rates for the following:

Lime 25 pounds per 1000 square feet

Sulfur 10 pounds per 1000 square feet

Iron 12 pounds per 1000 square feet

Aluminum Sulfate 50 pounds per 1000 square feet

3.4.4.2 Soil Conditioner Application Rates

Apply soil conditioners at rates as determined by laboratory soil analysis of the soils at the job site. For bidding purposes only apply at rates for the following:

Peat 200 pounds per acre

Sand 20 pounds per acre

Compost Derivatives 270 cubic yard per acre

3.4.4.3 Fertilizer Application Rates

Apply fertilizer at rates as determined by laboratory soil analysis of the soils at the job site. For bidding purposes only apply at rates for the following:

Organic granular fertilizer 250 pounds per acre.

Fertilizer Tablets for Trees and Shrubs			
	Container/Caliper Size	Tablet Size	No. of Tablets
Shrub:	2 gal	21 grams	2
Tree:	3 inches	21 grams	6

3.4.5 Root Control Barrier

Install root barrier panels in the soil in a vertical and surrounding application. Use appropriate holding device to assure fabric position. For vertical application, a minimum 2 inch soil cover is required over the top edge. Install per manufacturer's specifications.

3.5 PLANT BED PREPARATION

Verify location of underground utilities prior to excavation. Protect existing adjacent turf before excavations are made. Do not disturb topsoil and vegetation in areas outside those indicated on Drawings. Where planting beds occur in existing turf areas, remove turf to a depth that will ensure removal of entire root system. Measure depth of plant pits from finished grade. Depth of plant pit excavation must be as indicated and provide proper relation between top of root ball and finished grade. Install plant material as specified in paragraph PLANT INSTALLATION. Do not install trees within 10 feet of any utility lines or building walls.

3.6 PLANT INSTALLATION

3.6.1 Individual Plant Pit Excavation

Excavate pits at least twice as large in diameter as the size of ball or container to depth shown. Smaller pit sizes may be considered on a case by case basis in steeply sloped location.

3.6.2 Plant Beds with Multiple Plants

Excavate plant beds continuously throughout entire bed as outlined to depth shown.

3.6.3 Handling and Setting

Move plant materials only by supporting the root ball or container. Set plants on hand compacted layer of prepared backfill soil mixture 6 inches thick or native soil and hold plumb in the center of the pit until soil has been tamped firmly around root ball. Set plant materials, in relation to surrounding finish grade, one to 2 inches above depth at which they

were grown in the nursery, collecting field or container. Replace plant material whose root balls are cracked or damaged either before or during the planting process.

Plant material must be set in plant beds according to the drawings. Backfill soil mixture must be placed on previously scarified subsoil to completely surround the root balls, and must be brought to a smooth and even surface, blending to existing areas.

3.6.3.1 Balled and Burlapped Stock

Backfill with prepared soil mixture to approximately half the depth of ball and then tamp and water. Carefully remove or fold back excess burlap and tying materials from the top a minimum 1/3 depth from the top of the rootball. Tamp and complete backfill, place mulch topdressing, and water. Remove wires and non-biodegradable materials from plant pit prior to backfill operations.

3.6.3.2 Container Grown Stock

Remove from container and prevent damage to plant or root system.

3.6.3.3 Ground Covers and Vines

Plant after placing mulch topdressing. Do not remove plant materials from flats or containers until immediately before planting. Space at intervals indicated. Plant at a depth to sufficiently cover all roots. Start watering areas planted as required by temperature and wind conditions. Apply water at a rate sufficient to ensure thorough wetting of soil to a depth of 6 inches without run off or puddling. Smooth planting areas after planting to provide even, smooth finish. Mulch as indicated.

Smooth planting areas before planting to provide even, smooth finish. Plant after placing weed control fabric and mulch topdressing. Do not remove plant material from flats or containers until immediately before planting. Space at the intervals indicated. Plant at a depth to sufficiently cover all roots. Start watering areas planted as required by temperature and wind conditions. Apply water at a rate sufficient to ensure thorough wetting of soil to a depth of 6 inches without run off or puddling. Add mulch topdressing as needed.

3.6.4 Earth Mounded Watering Basin for Individual Tree Plant Pits

Form with topsoil around each plant by replacing a mound of topsoil around the edge of each tree plant pit. Watering basins must be 6 inches deep for trees. Eliminate basins around plants in plant beds containing multiple plants.

3.6.5 Erosion Control Material

Install in accordance with manufacturer's instructions.

3.6.6 Placement of Mulch Topdressing

Place specified mulch topdressing on top of weed control fabric covering total area enclosed by edging. Place mulch topdressing to a depth of 3 inches.

3.6.7 Mulch Topdressing

Provide mulch topdressing over entire planter bed surfaces and individual plant surfaces including earth mound watering basin around plants to a depth of 3 inches after completion of plant installation and before watering. Keep mulch out of the crowns of shrubs. Place mulch a minimum 2 to 3 inches away from trunk of shrub or tree. Place on top of any weed control fabric.

3.6.8 Fertilization

3.6.8.1 Fertilizer Tablets

Place fertilizer planting tablets evenly spaced around the plant pits to the manufacturer's recommended depth.

3.6.8.2 Granular Fertilizer

Apply granular fertilizer as a top coat prior to placing mulch layer and water thoroughly.

3.6.9 Watering

Start watering areas planted as required by temperature and wind conditions. Slow deep watering must be used. Apply water at a rate sufficient to ensure thorough wetting of soil to a depth of 12 inches without run off or puddling. Watering of other plant material or adjacent areas must be prevented.

3.6.10 Staking and Guying

3.6.10.1 Staking

Stake plants with the number of stakes indicated complete with double strand of 12 gage guy wire as detailed. Attach guy wire half the tree height but not more than 5 feet high. Drive stakes to a depth of 2-1/2 to 3 feet into the ground outside the plant pit. Do not injure the root ball. Use hose chafer guards where guy wire comes in contact with tree trunk.

3.6.10.2 Guying

Guy plants as indicated. Attach two strands of guying wire around the tree trunk at an angle of 45 degrees at approximately 1/2 of the trunk height. Protect tree trunks with chafing guards where guying wire contacts the tree trunk. Anchor guys to deadmen wood blocks or steel screw anchors. Fasten flags to each guying wire approximately 2/3 of the distance up from ground level. Provide turnbuckles as indicated.

3.6.10.3 Chafing Guards

Use hose chafing guards, as specified where guy wire will contact the plant.

3.6.10.4 Deadmen

Place deadmen minimum 18 inches below ground surface. Place equal distance from tree trunk and around the plant pit.

3.6.10.5 Wood Ground Stakes

Drive wood ground stakes into firm ground outside of plant pit with top of stake flush with ground. Place equal distance from tree trunk and around the plant pit.

3.6.10.6 Steel Screw Anchors

Insert steel screw anchors as recommended in manufacturer's data. Place equal distance from tree trunk and around the plant pit.

3.6.10.7 Flags

Securely fasten flags on each guy wire approximately two-thirds of the distance up from ground level.

3.6.11 Pruning

Prune in accordance with safety requirement of TCIA Z133.

3.6.11.1 Trees and Shrubs

Remove dead and broken branches. Prune to correct structural defects only. Retain typical growth shape of individual plants with as much height and spread as practical. Do not cut central leader on trees. Make cuts with sharp instruments. Do not flush cut with trunk or adjacent branches. Collars must remain in place. Pruning must be accomplished by trained and experienced personnel and must be accordance with TCIA A300P1.

3.6.11.2 Wound Dressing

Do not apply tree wound dressing to cuts.

3.7 RESTORATION AND CLEAN UP

3.7.1 Restoration

Turf areas, pavements and facilities that have been damaged from the planting operation must be restored to original condition at the Contractor's expense.

3.7.2 Clean Up

Excess and waste material must be removed from the installed area and must be disposed offsite at an approved landfill, recycling center, or composting center. Separate and recycle or reuse the following landscape waste materials: nylon straps, wire, ball wrap, burlap, and wood stakes. Adjacent paved areas must be cleared.

-- End of Section --

SECTION 33 11 00

WATER UTILITY DISTRIBUTION PIPING
02/18

~~PART 1 GENERAL~~

~~1.1 UNIT PRICES~~

~~Measurement and payment will be based on completed work performed in accordance with the drawings, specifications, and the Contract payment schedules.~~

~~1.1.1 Measurement~~

~~The length of water lines will be determined by measuring along the centerlines of the various sizes of pipe provided. Pipe will be measured from center of fitting to center of fitting, from center of water main to center of fire hydrant and from center of water main to end of service connection. No deduction will be made for the space occupied by valves or fittings.~~

~~1.1.2 Payment~~

~~Payment will be made for water lines at the Contract unit price per linear foot for the various types and sizes of water lines, and will be full compensation for all pipes, joints, specials, and fittings, complete and in place. Payment for fire hydrants, valves, and valve boxes will be made at the respective Contract unit price each for such items complete and in place. Payment will include providing all testing, plant, labor, and material and incidentals necessary to complete the work, as specified and as shown.~~

~~1.2 REFERENCES~~

~~The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.~~

~~AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)~~

~~AASHTO HB-17~~	~~(2002; Errata 2003; Errata 2005, 17th Edition) Standard Specifications for Highway Bridges~~

~~AMERICAN RAILWAY ENGINEERING AND MAINTENANCE-OF-WAY ASSOCIATION (AREMA)~~

~~AREMA Eng Man~~	~~(2017) Manual for Railway Engineering~~

~~AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)~~

~~ASME B1.20.1~~	~~(2013; R 2018) Pipe Threads, General Purpose (Inch)~~
~~ASME B1.20.3~~	~~(1976; R 2013) Dryseal Pipe Threads (Inch)~~

ASME B16.1	(2015) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250
ASME B16.3	(2016) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.4	(2016) Standard for Gray Iron Threaded Fittings; Classes 125 and 250
ASME B16.18	(2018) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.26	(2018) Standard for Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B18.2.2	(2015) Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)
ASME B18.5.2.1M	(2006; R 2011) Metric Round Head Short Square Neck Bolts
ASME B18.5.2.2M	(1982; R 2010) Metric Round Head Square Neck Bolts

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA B300	(2018) Hypochlorites
AWWA B301	(2010) Liquid Chlorine
AWWA C104/A21.4	(2016) Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
AWWA C105/A21.5	(2018) Polyethylene Encasement for Ductile-Iron Pipe Systems
AWWA C110/A21.10	(2012) Ductile-Iron and Gray-Iron Fittings for Water
AWWA C111/A21.11	(2017) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C115/A21.15	(2020) Flanged Ductile-Iron Pipe With Ductile-Iron or Gray-Iron Threaded Flanges
AWWA C151/A21.51	(2017) Ductile-Iron Pipe, Centrifugally Cast
AWWA C153/A21.53	(2019) Ductile-Iron Compact Fittings for Water Service
AWWA C200	(2012) Steel Water Pipe - 6 In. (150 mm) and Larger
AWWA C203	(2008) Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot-Applied

~~AWWA C205~~	~~(2018) Cement-Mortar Protective Lining and Coating for Steel Water Pipe - 4 In. (100 mm) and Larger - Shop Applied~~
~~AWWA C206~~	~~(2017) Field Welding of Steel Water Pipe~~
~~AWWA C207~~	~~(2018) Standard for Steel Pipe Flanges for Waterworks Service, Sizes 4 in. through 144 in. (100 mm through 3600 mm)~~
~~AWWA C208~~	~~(2017) Dimensions for Fabricated Steel Water Pipe Fittings~~
~~AWWA C209~~	~~(2019) Cold-Applied Tape Coatings for the Exterior of Special Sections, Connections and Fitting for Steel Water Pipelines~~
~~AWWA C210~~	~~(2007) Standard for Liquid Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines~~
~~AWWA C213~~	~~(2015) Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines~~
~~AWWA C300~~	~~(2016) Reinforced Concrete Pressure Pipe, Steel-Cylinder Type~~
~~AWWA C301~~	~~(2014) Prestressed Concrete Pressure Pipe, Steel-Cylinder Type~~
~~AWWA C303~~	~~(2017) Concrete Pressure Pipe, Bar-Wrapped, Steel-Cylinder Type~~
~~AWWA C500~~	~~(20019) Metal-Seated Gate Valves for Water Supply Service~~
~~AWWA C502~~	~~(2018) Dry-Barrel Fire Hydrants~~
~~AWWA C503~~	~~(2018) Wet-Barrel Fire Hydrants~~
~~AWWA C504~~	~~(2015) Standard for Rubber-Seated Butterfly Valves~~
~~AWWA C508~~	~~(2017) Swing-Check Valves for Waterworks Service, 2 In. Through 48-In. (50-mm Through 1,200-mm) NPS~~
~~AWWA C509~~	~~(2015) Resilient-Seated Gate Valves for Water Supply Service~~
~~AWWA C511~~	~~(2017) Reduced-Pressure Principle Backflow Prevention Assembly~~
~~AWWA C512~~	~~(2015) Air-Release, Air/Vacuum, and Combination Air Valves for Water and Wastewater Service~~
~~AWWA C515~~	~~(2015) Reduced-Wall, Resilient-Seated Gate~~

	~~Valves for Water Supply Service~~
~~AWWA C550~~	~~(2017) Protective Interior Coatings for Valves and Hydrants~~
~~AWWA C600~~	~~(2017) Installation of Ductile-Iron Mains and Their Appurtenances~~
~~AWWA C602~~	~~(2011) Cement-Mortar Lining of Water Pipelines in Place 4 In. (100 mm) and Larger~~
~~AWWA C604~~	~~(2011) Installation of Buried Steel Water Pipe 4 In. (100 mm) and Larger~~
~~AWWA C605~~	~~(2014) Underground Installation of Polyvinyl Chloride (PVC) and Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe and Fittings~~
~~AWWA C606~~	~~(2015) Grooved and Shouldered Joints~~
~~AWWA C651~~	~~(2014) Standard for Disinfecting Water Mains~~
~~AWWA C655~~	~~(2009) Field Dechlorination~~
~~AWWA C700~~	~~(2015) Cold-Water Meters - Displacement Type, Metal Alloy Main Case~~
~~AWWA C701~~	~~(2015) Cold-Water Meters - Turbine Type for Customer Service~~
~~AWWA C702~~	~~(2019) Cold-Water Meters - Compound Type~~
~~AWWA C703~~	~~(2019) Cold-Water Meters - Fire Service Type~~
~~AWWA C704~~	~~(2019) Propeller-Type Meters for Waterworks Applications~~
~~AWWA C706~~	~~(2010) Direct-Reading, Remote-Registration Systems for Cold-Water Meters~~
~~AWWA C707~~	~~(2010; R 2016) Encoder-Type Remote-Registration Systems for Cold-Water Meters~~
~~AWWA C800~~	~~(2014) Underground Service Line Valves and Fittings~~
~~AWWA C900~~	~~(2016) Polyvinyl Chloride (PVC) Pressure Pipe, and Fabricated Fittings, 4 In. Through 60 In. (100 mm Through 1,500 mm)~~
~~AWWA C906~~	~~(2015) Polyethylene (PE) Pressure Pipe and Fittings, 4 In. (100 mm) through 65 In., (1,575 mm) for Water Distribution and Transmission~~

~~AWWA C909~~	~~(2016) Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe, 4 In. (100 mm) and Larger~~
~~AWWA C950~~	~~(2020) Fiberglass Pressure Pipe~~
~~AWWA M6~~	~~(2012) Water Meters - Selection, Installation, Testing, and Maintenance~~
~~AWWA M9~~	~~(2008; Errata 2013) Manual: Concrete Pressure Pipe~~
~~AWWA M11~~	~~(2016) Steel Pipe: A Guide for Design and Installation~~
~~AWWA M23~~	~~(2020) Manual: PVC Pipe - Design and Installation - Third Edition~~
~~AWWA M41~~	~~(2009; 3rd Ed) Ductile-Iron Pipe and Fittings~~
~~AWWA M45~~	~~(2013; 3rd Ed) Fiberglass Pipe Design~~
~~AWWA M55~~	~~(2006) PE Pipe - Design and Installation~~

~~ASTM INTERNATIONAL (ASTM)~~

~~ASTM A47/A47M~~	~~(1999; R 2018; E 2018) Standard Specification for Ferritic Malleable Iron Castings~~
~~ASTM A48/A48M~~	~~(2003; R 2016) Standard Specification for Gray Iron Castings~~
~~ASTM A53/A53M~~	~~(2020) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless~~
~~ASTM A276/A276M~~	~~(2017) Standard Specification for Stainless Steel Bars and Shapes~~
~~ASTM A307~~	~~(2014; E 2017) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength~~
~~ASTM A536~~	~~(1984; R 2019; E 2019) Standard Specification for Ductile Iron Castings~~
~~ASTM A563~~	~~(2015) Standard Specification for Carbon and Alloy Steel Nuts~~
~~ASTM A563M~~	~~(2007; R 2013) Standard Specification for Carbon and Alloy Steel Nuts (Metric)~~
~~ASTM A746~~	~~(2018) Standard Specification for Ductile Iron Gravity Sewer Pipe~~
~~ASTM B32~~	~~(2008; R 2014) Standard Specification for~~

	~~Solder Metal~~
~~ASTM B61~~	~~(2015) Standard Specification for Steam or Valve Bronze Castings~~
~~ASTM B62~~	~~(2017) Standard Specification for Composition Bronze or Ounce Metal Castings~~
~~ASTM B88~~	~~(2020) Standard Specification for Seamless Copper Water Tube~~
~~ASTM B88M~~	~~(2020) Standard Specification for Seamless Copper Water Tube (Metric)~~
~~ASTM B584~~	~~(2014) Standard Specification for Copper Alloy Sand Castings for General Applications~~
~~ASTM C94/C94M~~	~~(2020) Standard Specification for Ready-Mixed Concrete~~
~~ASTM C150/C150M~~	~~(2020) Standard Specification for Portland Cement~~
~~ASTM C1433~~	~~(2016b) Standard Specification for Precast Reinforced Concrete Monolithic Box Sections for Culverts, Storm Drains, and Sewers~~
~~ASTM D1599~~	~~(2014; E 2015) Resistance to Short-Time Hydraulic Failure Pressure of Plastic Pipe, Tubing, and Fittings~~
~~ASTM D1784~~	~~(2020) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds~~
~~ASTM D1785~~	~~(2015; E 2018) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120~~
~~ASTM D2241~~	~~(2015) Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)~~
~~ASTM D2466~~	~~(2017) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40~~
~~ASTM D2467~~	~~(2015) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80~~
~~ASTM D2774~~	~~(2012) Underground Installation of Thermoplastic Pressure Piping~~
~~ASTM D2855~~	~~(2015) Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl~~

	Chloride) (PVC) Pipe and Fittings
ASTM D3035	(2015) Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter
ASTM D3139	(2019) Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
ASTM D3261	(2016) Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
ASTM D3839	(2014) Standard Guide for Underground Installation of "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe
ASTM D4161	(2014) "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Joints Using Flexible Elastomeric Seals
ASTM F402	(2005; R 2012) Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings
ASTM F477	(2014) Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F714	(2013; R 2019) Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter
ASTM F1483	(2017) Standard Specification for Oriented Poly(Vinyl Chloride), PVCO, Pressure Pipe
ASTM F1674	(2011) Standard Test Method for Joint Restraint Products for Use with PVC Pipe
ASTM F1962	(2011) Standard Guide for Use of Maxi-Horizontal Directional Drilling for Placement of Polyethylene Pipe or Conduit Under Obstacles, Including River Crossings
ASTM F2164	(2018) Standard Practice for Field Leak Testing of Polyethylene (PE) and Crosslinked Polyethylene (PEX) Pressure Piping Systems Using Hydrostatic Pressure
ASTM F2620	(2019) Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings

FOUNDATION FOR CROSS-CONNECTION CONTROL AND HYDRAULIC RESEARCH (FCCCHR)

FCCCHR List	(continuously updated) List of Approved

	Backflow Prevention Assemblies
FCCCHR Manual	(10th Edition) Manual of Cross-Connection Control

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-80	(2019) Bronze Gate, Globe, Angle and Check Valves

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 24	(2019; TIA 19-1) Standard for the Installation of Private Fire Service Mains and Their Appurtenances
NFPA 1961	(2013) Standard on Fire Hose

NSF INTERNATIONAL (NSF)

NSF 372	(2016) Drinking Water System Components - Lead Content
NSF/ANSI 14	(2019) Plastics Piping System Components and Related Materials
NSF/ANSI 61	(2020) Drinking Water System Components - Health Effects

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-600-01	(2016; with Change 3, 2019) Fire Protection Engineering for Facilities

UNDERWRITERS LABORATORIES (UL)

UL 246	(2011; Reprint Jul 2020) UL Standard for Safety Hydrants for Fire-Protection Service
UL 262	(2004; Reprint Oct 2011) Gate Valves for Fire-Protection Service
UL 312	(2010; Reprint Mar 2018) UL Standard for Safety Check Valves for Fire-Protection Service

UNI-BELL PVC PIPE ASSOCIATION (UBPPA)

UBPPA UNI-PUB-08	(2016) Tapping Guide for PVC Pressure Pipe

1.3 DEFINITIONS

1.3.1 Water Transmission Mains

Water transmission mains include water piping having diameters greater than 14 inch, specific materials, methods of joining and any appurtenances deemed necessary for a satisfactory system.

1.3.2 Water Mains

Water mains include water piping having diameters 4 through 14 inch, specific materials, methods of joining and any appurtenances deemed necessary for a satisfactory system.

1.3.3 Water Service Lines

Water service lines include water piping from a water main to a building service at a point approximately 5 feet from building or the point indicated on the drawings, specific materials, methods of joining and any appurtenances deemed necessary for a satisfactory system.

1.3.4 Additional Definitions

For additional definitions refer to the definitions in the applicable referenced standard.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are [for Contractor Quality Control approval.][for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance with Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Connections; G[, [_____]]

SD-03 Product Data

Pipe, Fittings, Joints and Couplings; G[, [_____]]

Ball And Socket Joint; G[, [_____]]

Valves; G[, [_____]]

Valve Boxes; G[, [_____]]

Fire Hydrants; G[, [_____]]

Pipe Restraint; G[, [_____]]

Tapping Sleeves; G[, [_____]]

Corporation Stops; G[, [_____]]

Backflow Preventer; G[, [_____]]

Railroad Crossing Casing Pipe; G[, [_____]]

Precast Concrete Thrust Blocks; G[, [_____]]

Disinfection Procedures; G[, [_____]]

SD-06 Test Reports

Backflow Preventer Tests; G[, [_____]]

Bacteriological Samples; G[, [_____]]

Post-Construction Fusion Report; G[, [_____]]

Hydrostatic Sewer Test

Leakage Test

Hydrostatic Test

SD-07 Certificates

Pipe, Fittings, Joints and Couplings

Shop-Applied Lining [and Coating]

Lining

Lining for Fittings

Valves

Fire Hydrants

Backflow Prevention Training Certificate

Backflow Tester Certification

Fusion Technician Qualifications; G[, [_____]]

Turbine Type Meters

Propeller Type Meters

Displacement Type Meters

Compound Type Meters

Fire Service Type Meters

Backflow Certificate

SD-08 Manufacturer's Instructions

Ductile Iron Piping

PVC Piping

PVCO Piping

Polyethylene (PE) Pipe

Fiberglass Pipe, Fittings, Joints And Joint Materials

Concrete Pressure Pipe

~~Prestressed Concrete Pressure Pipe~~

~~Reinforced Concrete Cylinder Pipe~~

~~PVC Piping For Service Lines~~

~~Copper Pipe For Service Lines~~

~~1.5 QUALITY CONTROL~~

~~1.5.1 Regulatory Requirements~~

~~Comply with NSF/ANSI 14 or NSF/ANSI 61 and NSF 372 for materials for potable water systems; comply with lead content requirements for "lead-free" plumbing as defined by the U.S. Safe Drinking Water Act effective January 2014. Provide materials bearing the seal of the National Sanitation Foundation (NSF) for potable water service.~~

~~Comply with NFPA 24 for materials, installation, and testing of fire main piping and components.~~

~~1.5.2 Qualifications~~

~~1.5.2.1 Backflow Preventers~~

~~1.5.2.1.1 Backflow Preventer Certificate~~

~~Certificate of Full Approval from FCCCHR List, University of Southern California, attesting that the design, size and make of each backflow preventer has satisfactorily passed the complete sequence of performance testing and evaluation for the respective level of approval. Certificate of Provisional Approval will not be acceptable.~~

~~[1.5.2.1.1.1 Backflow Tester Certificate~~

~~Prior to testing, submit to the Contracting Officer certification issued by the State or local regulatory agency attesting that the backflow tester has successfully completed a certification course sponsored by the regulatory agency.[Tester must not be affiliated with any company participating in any other phase of this Contract.]~~

~~]1.5.2.1.1.2 Backflow Prevention Training Certificate~~

~~Submit a certificate recognized by the State or local authority that states the Contractor has completed at least 10 hours of training in backflow preventer installations. The certificate must be current.~~

~~1.5.2.2 Fusion Technician Qualifications~~

~~Submit a certificate from the manufacturer of the fusible pipe that shows the fusion technician is fully qualified to install fusible pipe of the types and sizes being used. Qualification must be current as of the actual date of fusion performance on the project.~~

1.6 DELIVERY, STORAGE, AND HANDLING

1.6.1 Delivery and Storage

Inspect materials delivered to site for damage. Unload and store with minimum handling and in accordance with manufacturer's instructions. Store materials on site in enclosures or under protective covering. Store plastic piping, jointing materials and rubber gaskets under cover out of direct sunlight. Do not store materials directly on the ground. Keep inside of pipes, fittings, valves, fire hydrants, and other accessories free of dirt and debris.

1.6.2 Handling

Handle pipe, fittings, valves, fire hydrants, and other accessories in accordance with manufacturer's instructions and in a manner to ensure delivery to the trench in sound undamaged condition. Avoid injury to coatings and linings on pipe and fittings; make repairs if coatings or linings are damaged. Do not place other material, hooks, or pipe inside a pipe or fitting after the coating has been applied. Inspect the pipe for defects before installation. Carry, do not drag pipe to the trench. Use of pinch bars and tongs for aligning or turning pipe will be permitted only on the bare ends of the pipe. Clean the interior of pipe and accessories of foreign matter before being lowered into the trench and keep them clean during laying operations by plugging. Replace defective material without additional expense to the Government. Store rubber gaskets, not immediately installed, under cover or out of direct sunlight.

Handle ductile iron pipe, fittings, and accessories in accordance with AWWA C600 and AWWA M41. Handle PVC and PVCO pipe, fittings, and accessories in accordance with AWWA C605. Handle PE pipe, fittings, and accessories in accordance with AWWA M55. [Handle fiberglass pipe, fittings, and accessories in accordance with AWWA M45.][Handle steel pipe, fittings and accessories in accordance with AWWA C604.]

PART 2 PRODUCTS

2.1 MATERIALS

Provide all materials in accordance with AWWA C800 and as indicated herein. Provide valves and fittings with pressure ratings equivalent to the pressure ratings of the pipe.

2.1.1 Pipe, Fittings, Joints And Couplings

Submit manufacturer's standard drawings or catalog cuts, except submit both drawings and cuts for push-on [and rubber-gasketed bell-and-spigot] joints. Include information concerning gaskets with submittal for joints and couplings.

2.1.1.1 Ductile-Iron Piping

2.1.1.1.1 Pipe and Fittings

Pipe, [except flanged pipe,] AWWA C151/A21.51, [Pressure Class [_____]] [Thickness Class [_____]].[Flanged pipe, AWWA C115/A21.15.] Fittings, AWWA C110/A21.10 or AWWA C153/A21.53[; fittings with push-on joint ends are to meet the same requirements as fittings with mechanical-joint ends, except for the factory modified bell design]. Provide fittings with

pressure ratings equivalent to that of the pipe. Provide compatible pipe ends and fittings for the specified joints. Provide cement-mortar lining, AWWA C104/A21.4, [twice the] standard thickness on pipe and fittings.

2.1.1.1.2 Joints and Jointing Material

[Provide [push-on joints[or mechanical joints]] for pipe and fittings [unless otherwise indicated].] [Provide mechanical joints where indicated.] [Provide flanged joints where indicated.] [Provide mechanically coupled type joints using a sleeve-type mechanical coupling where indicated.] [Provide [grooved] [or] [shouldered] type joints where indicated.] [Provide insulating joints where indicated.] [Sleeve-type mechanical couplings in lieu of push-on joints are acceptable, subject to the limitations specified in the paragraph SLEEVE-TYPE MECHANICAL COUPLINGS.] [Utilize [grooved] [or] [shouldered] type joints in lieu of [flanged joint or] push-on joint, except where joint is buried.]

a. Push-On Joints: Shape of pipe ends and fitting ends, gaskets, and lubricant for joint assembly as recommended in AWWA C111/A21.11.

b. Mechanical Joints: Dimensional and material requirements for pipe ends, glands, bolts and nuts, and gaskets as recommended in AWWA C111/A21.11.

c. Flanged Joints: Bolts, nuts, and gaskets for flanged connections as recommended in Appendix A of AWWA C115/A21.15. Provide AWWA C115/A21.15 ductile iron flanges and conform to ASME B16.1, Class 125. [Provide ASTM A536 epoxy coated steel set screw flanges. Gasket and lubricants for set screw flanges, in accordance with mechanical-joint gaskets specified in AWWA C111/A21.11.]

d. Insulating Joints: Designed to prevent metal-to-metal contact at the joint between adjacent sections of piping. Provide flanged type joint with insulating gasket, insulating bolt sleeves, and insulating washers. Provide full face dielectric type gaskets, as recommended in the Appendix to AWWA C115/A21.15. Bolts and nuts, as recommended in the Appendix to AWWA C115/A21.15.

e. Sleeve-Type Mechanical Coupled Joints: As specified in the paragraph SLEEVE-TYPE MECHANICAL COUPLINGS.

[f. [Grooved] [and] [Shouldered] Type Joints: [Grooved] [and] [shouldered] pipe ends and couplings, AWWA C606. Joint dimension as specified in AWWA C606 for rigid joints [, joint dimensions as specified in AWWA C606 for flexible joints].

]2.1.1.2 Plastic Piping

2.1.1.2.1 PVC and PVCO Piping

2.1.1.2.1.1 PVC Piping

AWWA C900 plain end or gasket bell end pipe meeting or exceeding ASTM D1784 cell class 12454, with a minimum Pressure Class [150 (DR27.5)], [165 (DR25)], [200 (DR21)], [235 (DR 18)], [250 (DR17)] [305 (DR 14)] with ductile iron outside diameter (DIOD).

~~2.1.1.2.1.2 PVCO Piping~~

~~AWWA C909, ASTM F1483 plain end or gasket bell end pipe meeting or exceeding ASTM D1784 cell class 12454, Pressure Class [165] [_____] PVCO pressure pipe, with ductile iron outside diameter (DIOD).~~

~~2.1.1.2.1.3 Fittings for PVC and PVCO Pipe~~

~~Gray iron or ductile iron fittings, AWWA C110/A21.10 with special fittings in accordance with Appendix B or AWWA C153/A21.53, with cement-mortar lining for fittings, AWWA C104/A21.4, standard thickness. Fittings with push-on joint ends are to conform to the same requirements as fittings with mechanical-joint ends, except for the factory modified bell design compatible for use with PVC pipe as specified.~~

~~[Fittings from material that meets or exceeds ASTM D1784 cell class 12454 and is the same material as the pipe with elastomeric gaskets, in conformance with AWWA C605 and AWWA C900.~~

~~]2.1.1.2.1.4 Joints and Jointing Material for PVC and PVCO Piping~~

~~a. Push-on joints: Use jointing material in accordance with ASTM D3139 and AWWA C111/A21.11 between pipes, pipes and metal fittings, valves, and other accessories or compression-type joints/mechanical joints. Provide each joint connection with an elastomeric gasket compatible for the bell or coupling used. Gaskets for push-on joints for pipe, ASTM F477. Gaskets for push-on joints and compression-type joints/mechanical joints for joint connections between pipe and metal fittings, valves, and other accessories, AWWA C111/A21.11, respectively, for push-on joints and mechanical joints.~~

~~b. Mechanical Joint: Use mechanically coupled joints having a sleeve-type mechanical coupling, as specified in the paragraph SLEEVE-TYPE MECHANICAL COUPLINGS, as an optional jointing method for plain-end PVC pipe, subject to the limitations specified for mechanically coupled joints using a sleeve-type mechanical coupling as specified for compression-type joints in ASTM D3139. Provide jointing material in accordance with AWWA C111/A21.11 between pipe and sleeve-type mechanical couplings.~~

~~2.1.1.2.2 PVC Piping for Service Lines~~

~~2.1.1.2.2.1 Pipe and Fittings~~

~~Provide ASTM D1784 cell class 12454 pipe and fittings of the same PVC material.~~

~~a. ASTM D1785, Schedule 40 with ASTM D2466 Schedule 40 or ASTM D2467 Schedule 80 fittings.~~

~~b. ASTM D2241 pipe and fittings with SDR as necessary to provide 150 psi minimum pressure rating with ASTM D2466 Schedule 40 or ASTM D2467 Schedule 80 fittings.~~

~~2.1.1.2.2.2 Joints and Connections~~

~~Fittings may be joined by the solvent-cement method or threading.~~

~~2.1.1.2.2.3 Solvent Joining~~

~~Provide solvent joints in accordance with ASTM D2855.~~

~~2.1.1.2.3 Polyethylene (PE) Pipe~~

~~AWWA C906, ASTM D3035, PE4710, material designation code[CC2] [CC3] with a minimum Pressure Class [200 (DR11)] [250 (DR 9)] [335 (DR 7)] with ductile iron outside diameter (DIOD).~~

~~2.1.1.2.3.1 Fittings For PE Pipe~~

~~AWWA C906, AWWA M55, ASTM D3035, molded and manufactured to comply with ASTM F714.~~

~~2.1.1.2.3.2 Joints and Jointing Materials~~

~~Mechanical Joint: AWWA C111/A21.11 DIOD Mechanical joint adapter and gaskets for mechanical joints for joint connections between pipe and metal fittings, valves, and other accessories.~~

~~2.1.1.3 Fiberglass Pipe, Fittings, Joints and Joint Materials~~

~~AWWA C950, Type [I] [II], Pressure Class 150 with a minimum pipe stiffness of 36 psi, Grade [1] [2] [3] [4], Liner [A] [B] [C] [D] [E] [F].~~

~~a. Provide pipe with a quick-burst strength greater than or equal to four times the normal working pressure of the pipe. The quick-burst strength test is to meet the requirements of ASTM D1599.~~

~~b. Provide fittings and specials compatible with the pipe supplied. Filament wound or molded fittings up to 6 inches are to conform to AWWA C950. Provide cement-mortar lined iron fittings in accordance with AWWA C104/A21.4 and conforming to AWWA C110/A21.10 and AWWA C111/A21.11.[Provide fittings and specials required for closures, curves, bends, branches and connections to valves, pipe, or structures consistent with the details furnished by the manufacturer and to AWWA C300, AWWA C301, or AWWA C303.] Provide fittings that will withstand working and testing pressures specified for the pipe.~~

~~c. Provide bell and spigot joints with elastomeric gaskets in accordance with ASTM D4161. Provide mechanically coupled joints with elastomeric gasket, flanged, threaded and bonded coupling, or bell and spigot with compatible adhesive, provided they are compatible with the pipe and convey water at the pressure and temperature of the pipe.~~

~~2.1.1.4 [Concrete Pressure Pipe] [Prestressed Concrete Pressure Pipe (PCCP)] [and] [Reinforced Concrete Cylinder Pipe (RCCP)]~~

~~2.1.1.4.1 Piping, Fittings, Joints and Jointing Material~~

~~[Prestressed concrete pressure pipe (PCCP), AWWA C301.][Reinforced Concrete Cylinder Pipe (RCCP), steel-cylinder type AWWA C300.][Concrete pressure pipe, reinforced with a steel cylinder that is helically wrapped with mild steel bar reinforcement AWWA C303.]~~

~~[Pipe has been designed for the following minimum conditions:~~

~~a. Pressure rating - [_____] psi~~

b. Earth cover - [_____] feet

c. Water hammer - [_____] percent of pressure rating

d. Live load - [AASHTO H 20 truck loading] [_____]

]

Provide fittings that match the same specification as that used for the pipe and are designed as specified for the pipe. [Utilize [Type II] [Type V] [low alkali cement] pipe and fittings that match the requirements of ASTM C150/C150M.] Include factory inscribed pressure rating identification markings for pipe and fittings.

Jointing Material: Provide rubber-gasket joints compatible with the type using a bell and spigot joint design of steel.

2.1.1.5 Steel Piping

2.1.1.5.1 Pipe and Fittings

Pipe, AWWA C200. Fittings, AWWA C208 and AWWA C200, with reference to the requirements specified therein for "Special Sections." Provide cement-mortar lining and [cement-mortar] [coal-tar enamel] [coal-tar epoxy] coating on pipe and fittings [for underground lines] in accordance with applicable AWWA standard. Provide cement-mortar lining on [pipe and fittings for aboveground lines.] Utilize pipe ends and fittings compatible for the joints and jointing materials used.

a. Utilize welded or seamless pipe with plain, or shouldered and grooved ends in accordance with AWWA C606 for use with mechanical couplings or bell-and-spigot ends with rubber gaskets. Provide bell-and-spigot ends for sizes less than 6 inches diameter in accordance with AWWA C200.

b. Provide fittings and specials made of the same material as the pipe. Use specials and fittings made of standard steel tube turns or segmentally welded sections, with ends to accommodate the type of couplings or joints specified for the pipe. Match the thickness rating of pipe fittings and specials to the thickness specified and the pressure rating calculated for the pipe with which they are used. Provide identical protective materials for fittings and specials as specified for the pipe. Hand wrap, line, or coat specials and fittings that cannot be mechanically wrapped, lined, or coated using the same material used for the pipe with the same number of applications of each material, smoothly applied.

2.1.1.5.2 Wall Thickness for Pipe and Fittings

The minimum metal thickness for steel pipe wall is [_____] inches, based on steel having a yield strength of [_____] psi. Pipe has been designed for the following minimum conditions:

Pressure rating	[_____] psi
[Earth cover]	[[_____] feet]
Water hammer	40 percent of pressure rating

Live load	AASHTO H 20 truck loading
Allowable deflection	2 percent of nominal pipe diameter

Ensure that the wall thickness of fittings is equal to or greater than that required for the pipe. Reinforce fittings in accordance with methods given in AWWA M11, Chapter 13, "Supplementary Design Data and Details" when necessary to meet the pressure test requirements.

2.1.1.5.3 Joints and Jointing Material

Provide rubber-gasketed pipe and fitting bell-and-spigot joints[, welded joints,] or the mechanically coupled type using a sleeve-type mechanical coupling[, unless otherwise specified].[Provide flanged joints where indicated.][Provide mechanically coupled type joints using a sleeve type mechanical coupling where indicated.][Provide [grooved][or][shouldered] type where indicated.][Provide insulating joints where indicated.][It is acceptable to use [grooved][or][shouldered] type joints in lieu of flanged joints.]

a. Rubber-Gasketed Bell-and-Spigot Joints: Provide joints and pipe ends in accordance with the pipe manufacturer's standard for this type of joint, except that the joint is to also meet the requirements specified for rubber-gasketed joints and rubber gaskets in AWWA C200.

b. Welded Joints: Provide electrodes of the quality specified in AWWA C206.

c. Sleeve-Type Mechanical Coupled Joints: As specified in paragraph SLEEVE-TYPE MECHANICAL COUPLINGS.

d. [Grooved] [and] [Shouldered] Type Joints: [Provide pipe ends grooved by roll grooving or with welded-on adapters and cut grooves. Provide grooves made by roll grooving with dimensions as recommended by the coupling manufacturer. Match dimensions for cut grooves in adapters to AWWA C606.]Couplings [and shouldered pipe ends], AWWA C606. Match the joint dimensions as specified in AWWA C606 for rigid joint[, joint dimensions as specified in AWWA C606 for flexible joints].

e. Flanged Joints: Provide pipe ends with steel flanges, AWWA C207; [Class D] [Class E]. Bolts and nuts for flanged connections, AWWA C207. Rubber gaskets, AWWA C207; asbestos gaskets are not allowed.

f. Insulating Joints: Designed to prevent metal-to-metal contact at the joint between adjacent sections of piping. Provide flange type joints with insulating gasket, insulating bolt sleeves, and insulating washers. Provide dielectric type gaskets, full face, and in other respects as recommended in the Appendix to AWWA C115/A21.15. Bolts and nuts as recommended in the Appendix to AWWA C115/A21.15.

~~2.1.1.5.4 Lining [and Coating]:~~

~~a. Cement-Mortar Lining: AWWA C205, shop-applied. Materials for cement mortar lining in place as specified in AWWA C602.~~

~~b. Cement-Mortar Coating: AWWA C205, shop-applied.~~

~~c. Coal-Tar Enamel Coating: Except as otherwise specified, prepare, prime, and coat piping with hot-applied coal-tar enamel and a bonded [single layer of felt wrap in accordance with AWWA C203] [double felt wraps in accordance with AWWA C203]. Provide shop applied coating of fibrous-glass mat felt material as specified in Section 10 of AWWA C203. Do not use asbestos felt.~~

~~d. Coal-Tar Epoxy Coating: Clean, prime, and topcoat piping with coal-tar epoxy coating system in accordance with AWWA C210. Shop-apply coating.~~

~~[2.1.1.5.5 Steel Piping for Service Lines~~

~~Pipe, ASTM A53/A53M, Standard Weight, zinc-coated. Fittings, ASME B16.4, Class 125, zinc coated; or ASME B16.3, Class 150, zinc coated, threaded.~~

~~[~~
~~Mechanically apply, in a factory or plant especially equipped for the purpose, the protective materials for steel pipe. Unless otherwise indicated, the materials consist of [one of the following] [the following] for the indicated pipe material and size:~~

~~Clean pipe and fittings less than 3 inches in diameter of foreign material by wire brushing and solvent cleaning, and apply one coat of coal-tar primer and two coats of coal-tar enamel matching the requirements of AWWA C203; protect threaded ends of pipe and fittings prior to coating.~~

~~]]2.1.1.6 Copper Pipe For Service Lines~~

~~2.1.1.6.1 Copper Tubing and Associated Fittings~~

~~Provide ASTM B88, Type K copper tubing. Provide AWWA C800 fittings. AWWA C800 includes ASME B1.20.3, ASME B1.20.1, ASME B16.18 solder-type joint fittings.~~

~~[2.1.1.7 Trenchless Piping~~

~~2.1.1.7.1 PVC Pipe~~

~~AWWA C900 plain end meeting or exceeding ASTM D1784 cell class 12454, plastic formulated for fusing with a minimum Pressure Class [235 (DR18)] [305 (DR 14)] with ductile iron outside diameter (DIOD).~~

~~2.1.1.7.1.1 Butt Fusion~~

~~Use butt fusion jointing method for plain-end PVC pipe. Comply with AWWA C900 and AWWA C605 for butt fusion joints. No offset in alignment between adjacent pipe joints of fittings is permitted. The fusion technician must be qualified by the fusion equipment manufacturer to thermally butt-fuse the size of pipe used at the time of fusion performance. Each joint must be datalogged, recorded and submitted for review and meet the requirements of ASTM F1674.~~

~~2.1.1.7.2 PE Pipe~~

~~Provide in accordance with AWWA C906, ASTM D3035, ASTM F1962, PE4710, with material designation code [CC2] [CC3] with a minimum Pressure Class of [250 (DR 9)] [335 (DR 7)]with ductile iron outside diameter (DIOD).~~

~~2.1.1.7.2.1 Butt Fusion Fittings~~

~~Use AWWA C906, AWWA M55, ASTM D3261 ANSI Class 250 or as necessary to provide minimum pressure rating.~~

~~2.1.1.7.2.2 Butt Fusion~~

~~Use butt fusion jointing method for plain-end PE pipe. Comply with AWWA C906 and ASTM F2620 for Butt Fusion joints. No offset in alignment between adjacent pipe joints of fittings is permitted. The fusion technician must be qualified by the fusion equipment manufacturer to thermally butt-fuse the size of pipe used at the time of fusion performance. Each joint must be datalogged, recorded and submitted for review.~~

~~2.1.1.7.3 Ductile Iron Ball and Socket Joint~~

~~Use centrifugally cast ductile iron pipe meeting the applicable requirements of AWWA C151/A21.51 [Pressure Class [_____]] [Thickness Class [_____]] and in accordance with pipe manufacturer's instructions. The separately cast Ductile-Iron ball, bell and retainer ring conforms with the requirements of ASTM A536, Grade 70-50-05. Critical surfaces of the ball, bell socket and retainer ring are machined.~~

~~2.1.1.7.3.1 Fittings~~

~~Ductile iron bell, ball and retainer ring meeting the applicable requirements of AWWA C110/A21.10and in accordance with pipe manufacturer's instructions for ball and socket joint pipe.~~

~~][2.1.1.8 Piping Beneath Railroad Right-of-Way~~

~~Piping passing under the right-of-way of a commercial railroad is to conform to the specifications for pipelines conveying nonflammable substances in AREMA Eng Man. Provide ductile-iron pipe in lieu of cast-iron pipe. Ductile-iron railroad crossing casing pipe is to conform to and have strength computed in accordance with ASTM A746.~~

~~]2.1.2 Valves~~

~~[Provide a protective interior coating in accordance with AWWA C550.~~

~~]2.1.2.1 Gate Valves 3 Inch Size and Larger [on Buried Piping]~~

~~AWWA C500, AWWA C509, AWWA C515, or UL 262 and:~~

~~a. AWWA C500: nonrising stem type with double-disc gate and mechanical-joint ends or push-on joint ends compatible for the adjoining pipe~~

~~b. AWWA C509 or AWWA C515: nonrising stem type with mechanical-joint ends[or resilient-seated gate valves 3 to 12 inches in size]~~

c. UL 262: inside-screw type with operating nut, double-disc or split-wedge type gate, designed for a hydraulic working pressure of 175[_____] psi, and have mechanical-joint ends or push-on joint ends as appropriate for the pipe to which it is joined.

Match materials for UL 262 gate valves to the reference standards specified in AWWA C500. Gate valves open by counterclockwise rotation of the valve stem. Stuffing boxes have 0-ring stem seals[, except for those valves for which gearing is specified, in which case use conventional packing in place of 0-ring seal]. Stuffing boxes are bolted and constructed so as to permit easy removal of parts for repair.[Use gate valves with special ends for connection to[cement piping or] sleeve-type mechanical coupling in lieu of mechanical-joint ends and push-on joint ends.] Provide valve ends and gaskets for connection to[cement piping or to] sleeve-type mechanical couplings that conform to the requirements specified [respectively]for the [joint or]coupling. [Provide AWWA C500 [_____] inch gate valves with gearing[and indicator].][Where an indicator post are shown, provide an indicator post flange for AWWA C500, AWWA C509, or AWWA C515 gate valves conforming to the requirements of UL 262.][Provide AWWA C500 [_____] inch gate valves with bypasses.] [Provide gate valves [on [_____] inch service lines] with threaded ends.][Gate valves[on [_____] inch service lines] have ends compatible with joining to the pipe used;[push-on joint ends or mechanical-joint ends for joining to ductile-iron pipe][or][push-on joint ends or mechanical-joint ends for joining to PVC water main pipe]; with AWWA C111/A21.11 gaskets and pipe ends.] Provide all valves from one manufacturer.

2.1.2.2 Gate Valves 3 Inch Size and Larger [in Valve Pit(s)] [and] [Aboveground Locations]

AWWA C500, AWWA C509, AWWA C515, or UL 262 and:

a. AWWA C500: [outside-screw-and-yoke rising-stem][nonrising stem] type with [double-disc][solid-wedge] gates and flanged ends

b. AWWA C509 or AWWA C515: [outside-screw-and-yoke rising-stem][nonrising stem] type with flanged ends

c. UL 262: [outside-screw-and-yoke][inside-screw] type, with [double-disc or split-wedge][solid or one-piece] type gate and flanged ends, and designed for a hydraulic working pressure of 175[_____] psi

Match materials for UL 262 gate valves to the reference standards specified in AWWA C500. [[[_____] inch]Gate valves are nonrising stem type or inside-screw type [where indicated].] [[[_____] inch size]Gate valves are solid-wedge gates or solid or one-piece type gates[where indicated].]Provide gate valves with handwheels that open by counterclockwise rotation of the valve stem. Bolt and construct stuffing boxes so as to permit easy removal of parts for repair. In lieu of flanged ends, provide valves with [grooved][or][shouldered] ends compatible with [grooved][or][shouldered] type joints, as specified in the paragraph DUCTILE-IRON PIPING.[Provide valves [_____] inch size with gearing[and indicator], AWWA C500 or AWWA C509.][Provide [_____] inch size valve with bypasses, AWWA C500.] Provide all valves from one manufacturer.

~~2.1.2.3 Check Valves~~

~~[Provide a protective interior coating in accordance with AWWA C550.]Swing-check type, AWWA C508 or UL 312 and:~~

~~a. AWWA C508: Iron or steel body and cover and flanged ends~~

~~b. UL 312: Cast iron or steel body and cover, flanged ends, and designed for a minimum working pressure of [150] [_____] psi.~~

~~Materials for UL 312 check valves are to match the reference standards specified in AWWA C508. Provide check valves with a clear port opening.[Provide [spring-loaded][weight-loaded] check valves[where indicated].][Class 125 flanges are to match ASME B16.1.] Provide [grooved][or][shouldered] ends [grooved][or][shouldered] type joints, as specified in the paragraph DUCTILE-IRON PIPING in lieu of flanged ends. Provide all check valves from one manufacturer.~~

~~2.1.2.4 Rubber-Seated Butterfly Valves~~

~~Provide rubber-seated butterfly valves and wafer type valves that match the performance requirements of AWWA C504. Wafer type valves not meeting laying length requirements are acceptable if supplied and installed with a spacer, providing the specified laying length. Meet all tests required by AWWA C504. Flanged-end valves are required in a pit. Provide a union or sleeve-type coupling in the pit to permit removal. Direct-bury mechanical-end valves 3 through 10 inches in diameter. Provide a valve box, means for manual operation, and an adjacent pipe joint to facilitate valve removal. Provide valve operators that restrict closing to a rate requiring approximately 60 seconds, from fully open to fully closed.~~

~~2.1.2.5 Pressure Reducing Valves~~

~~Maintain a constant downstream pressure regardless of fluctuations in demand. Using pressure reducing valves capable of providing [_____] psi operating pressure on the inlet side, with outlet pressure set for [_____] psi. Provide hydraulically-operated, pilot controlled, globe or angle type valves that are capable of being actuated either by diaphragm or piston. Provide diaphragm-operated, adjustable, spring-loaded type pilot controls made of lead-free bronze with stainless steel working parts, designed to permit flow when controlling pressure exceeds the spring setting. Construct the bodies of bronze, cast iron or cast steel with lead-free bronze trim; the valve stem of stainless steel; the seat of lead-free bronze; and the valve discs and diaphragms of synthetic rubber. Provide [threaded][flanged] ends.~~

~~2.1.2.6 Air Release, Air/Vacuum, and Combination Air Valves~~

~~Provide AWWA C512 air release [, air vacuum] and combination air valves that release air and prevent the formation of a vacuum. Provide valves with an iron body, lead-free bronze trim and stainless steel float that automatically releases air when the lines are being filled with water and admits air into the line when water is being withdrawn in excess of the inflow.~~

~~2.1.2.7 Water Service Valves~~

~~2.1.2.7.1 Gate Valves Smaller than 3 Inch in Size [on Buried Piping]~~

~~Gate valves smaller than 3 inch size [on Buried Piping] MSS SP-80, Class 150, solid wedge, nonrising stem, with flanged or threaded end connections, a union on one side of the valve, and a handwheel operator.~~

~~2.1.2.7.2 Gate Valves Smaller Than 3 Inch Size in Valve Pits~~

~~MSS SP-80, Class 150, solid wedge, inside screw, rising stem. Provide valves with flanged or threaded end connections, a union on one side of the valve, and a handwheel operator.~~

~~2.1.2.7.3 Check Valves Smaller than 2 Inch in Size~~

~~Provide check valves with a minimum working pressure of 150 psi or as indicated with a clear waterway equal to the full nominal diameter of the valve. Valves open to permit flow when inlet pressure is greater than the discharge pressure, and close tightly to prevent return flow when discharge pressure exceeds inlet pressure. Cast the size of the valve, working pressure, manufacturer's name, initials, or trademark on the body of each valve.~~

~~Provide valves for screwed fittings, made of lead-free bronze and in conformance with MSS SP-80, Class 150, Types 3 and 4 compatible for the application.~~

~~2.1.2.8 Valve Boxes~~

~~Provide a valve box for each gate valve[on buried piping][, except where indicator post is shown]. Construct adjustable valve boxes manufactured from [cast iron][or][precast concrete] of a size compatible for the valve on which it is used.[Provide cast iron valve boxes with a minimum cover and wall thickness of 3/16 inch and conforming to ASTM A48/A48M, Class 35B. Coat the cast-iron box with a heavy coat of bituminous paint.][Provide a round head.] Cast the word "WATER" on the lid. The minimum diameter of the shaft of the box is [5 1/4 inches][as indicated]. Provide [ASTM C1433] precast concrete valve box.[Provide precast concrete boxes installed in locations subjected to vehicular traffic[to withstand AASHTO load designation as outlined in AASHTO HB-17][_____].] [Manufacture precast concrete boxes in accordance with Section 03 42 13.00 10 PLANT-PRECAST CONCRETE PRODUCTS FOR BELOW GRADE CONSTRUCTION.]~~

~~2.1.2.9 Valve Pits~~

~~Construct the valve pits at locations indicated or as required above and in accordance with the details shown.~~

~~2.1.3 Blowoff Valve Assemblies~~

~~Provide blowoff valve assemblies complete with all pipe, fittings, valve, valve box, riser box and lid, riser extension, discharge fitting and other materials required to connect to the water main. Provide blow off valve assemblies 4 inches or larger with AWWA C110/A21.10 or AWWA C153/A21.53 fittings.[Provide a blowoff valve assembly with a removable riser.]~~

2.1.4 Fire Hydrants And Hose Houses

2.1.4.1 Fire Hydrants

Provide fire hydrants where indicated. Paint fire hydrants with at least one coat of primer and two coats of enamel paint. Paint barrel and bonnet colors in accordance with UFC 3-600-01. Stencil fire hydrant number and main size on the fire hydrant barrel using black stencil paint.

[Provide a protective epoxy interior coating conforming to AWWA C550 on those portions of the fire hydrant continuously in contact with sea water or salt water.
]

2.1.4.1.1 [Dry-Barrel Type] [and] [Wet-Barrel Type] Fire Hydrants

Provide [Dry-barrel type fire hydrants, AWWA C502 or UL 246, "Base Valve" with 6 inch inlet, 5 1/4 inch valve opening, one [4 1/2] [_____] inch pumper connection, and two 2 1/2 inch hose connections.] Provide [Wet-barrel type fire hydrants, AWWA C503 or UL 246, "Wet Barrel" with 6 inch inlet, one [4 1/2] [_____] inch pumper connection, and two 2 1/2 inch hose connections. Individually valve pumper connection and hose connections with independent nozzle gate valves.]

Provide [mechanical-joint or push-on joint end] [mechanical-joint end only] inlet [, except where flanged end is indicated]; with end matching requirements [as specified in [AWWA C502] [or] [AWWA C503] or UL 246] [_____] for size and shape of operating nut, cap nuts, and threads on hose and pumper connections. Provide fire hydrants with [frangible sections as mentioned in AWWA C502] [breakable features as mentioned in AWWA C503]. Provide fire hydrant with special couplings joining [upper and lower sections of fire hydrant barrel] [and upper and lower sections of fire hydrant stem] that break from a force imposed by a moving vehicle.

2.1.4.1.2 Flush-Type Fire Hydrants

Provide flush-type fire hydrants that conform to the applicable requirements of AWWA C502, except that they are designed to permit placement of fire hydrant below surface of pavement. Provide 6 inch inlet, 4 1/4 inch minimum valve opening, one [4 1/2] [_____] inch pumper connection, and one 2 1/2 inch hose connection that have readily accessible hose and pumper connections and operating nuts enclosed in a cast iron box with a cast-iron cover set flush with the pavement. Provide flush lifting cover handle. Inlet has either mechanical-joint or push-on joint end [, except where flanged end is indicated]. Size and shape of operating nut and cap nuts and threads on hose and pumper connections as [specified in AWWA C502] [indicated].

2.1.4.2 Fire Hydrant Hose Houses

Provide hose houses matching the requirements of NFPA 24 at each fire hydrant indicated on the drawings to have a fire hydrant hose house.

2.1.4.2.1 Additional Equipment

Provide the following equipment, in addition to that listed in NFPA 24, Hose Houses and Equipment, with each hose house:

a. 200 feet of 2-1/2 inch woven jacketed, rubber lined hose matching the requirements of NFPA 1961 with a minimum service test pressure of 300

psi; 100 feet of 1-1/2 inch woven jacketed, rubber lined hose matching the requirements of NFPA 1961 with a minimum service test pressure of 300 psi;

b. One gated 2-1/2 by 1-1/2 by 1-1/2 inch wye;

c. One playpipe for 2-1/2 inch hose with 1 inch shutoff nozzle tip;

d. One playpipe for 1-1/2 inch hose with 1/2 inch shutoff nozzle or combination nozzle;

e. Two adapter fittings, 2-1/2 to 1-1/2 inch;

f. Two spanners for 1-1/2 inch hose.

2.1.5 Meters

Submit certificates certifying all required and recommended tests set forth in the referenced standard and AWWA M6 have been performed and comply with all applicable requirements of the referenced standard and AWWA M6 within the past three years. Include certification that each meter has been tested for accuracy of registration and that each meter complies with the accuracy and capacity requirements of the referenced standard when tested in accordance with AWWA M6.

Include a register with all meters whether they are or are not connected to a remote reading system.

[2.1.5.1 Turbine Type Meters

Provide AWWA C701 [Class I] [Class II] [Advanced Metering Infrastructure (AMI) and Direct Digital Communication (DDC) compatible] meter with a strainer screen. Main casing constructed of [copper alloy containing not less than 75 percent copper] [[cast iron] [fabricated steel] with protective coating in accordance with AWWA C213 or AWWA C550].

][2.1.5.2 Propeller Type Meters

Provide AWWA C704 [Advanced Metering Infrastructure (AMI) and Direct Digital Communication (DDC) compatible] meter. Flow tubes or main cases constructed of [cast iron] [fabricated steel] [with protective coating in accordance with AWWA C153/A21.53, AWWA C210 or AWWA C213].

][2.1.5.3 Displacement Type Meters

Provide AWWA C700[Advanced Metering Infrastructure (AMI) and Direct Digital Communication (DDC) compatible] meter with [nutating disk][oscillating piston]. Pressure casings constructed of copper alloy containing not less than 75 percent copper.[Provide registers with [breakable][non-breakable] covers and straight-reading [permanently sealed][replaceable change gear] registers.][Provide non-breakable covers of copper alloy containing not less than 75 percent copper] copper alloy conforming to ASTM B584. For meter sizes 1/2 inch through 1 inch provide [split-case] [frost-protection-type design].

][2.1.5.4 Compound Type Meters

Provide AWWA C702 [Advanced Metering Infrastructure (AMI) and Direct Digital Communication (DDC) compatible] meter [with strainers]. Main

casing constructed of [copper alloy containing not less than 75 percent copper] [[cast iron] [fabricated steel] [with protective coating in accordance with AWWA C213 or AWWA C550]]. Equip with tapped bosses near the outlet for field testing purposes.

][2.1.5.5 Fire Service Type Meters

Provide AWWA C703[Advanced Metering Infrastructure (AMI) and Direct Digital Communication (DDC) compatible][turbine type] meter[with strainers]. Main casing constructed of[copper alloy containing not less than 75 percent copper][cast iron with protective coating in accordance with AWWA C550]. Equip with a[mechanical display-type][electronic display-type] straight-reading register.

]2.1.5.6 Register

Provide [AWWA C700] [AWWA C701] [AWWA C702] [AWWA C703] [open] [sealed] [permanently sealed] straight-reading register [for use in a submerged environment] supplied by the meter manufacturer. Equip register with [U.S. gallons][cubic feet] readings.[Use [a direct reading remote register designed in accordance with AWWA C706][an encoder type remote register designed in accordance with AWWA C707]].

[2.1.5.7 Strainers

Provide [AWWA C701][AWWA C702][AWWA C703] strainer recommended and supplied by the meter manufacturer. Provide strainer of the same material as the meter body (i.e., bronze, ductile, or stainless).

]2.1.5.8 Meter Connections

[Provide [flanged] [female screw threads] [_____] main case connection fittings.][Provide connections compatible with the type of pipe and conditions encountered.]

[2.1.5.9 Advanced Metering Infrastructure

[The Government will supply][Provide] an Advanced Metering Infrastructure (AMI) compatible water meter(s) [for the Contractor to install] and connect to the existing AMI Data Acquisition System (DAS). Use the existing Government laptop computers to configure the meter using existing software loaded on the computer. Modifications to existing software on the computer or the addition of software to the computer is not allowed. The Contractor must ensure that the meter(s) transmit the metered data to the DAS. The current meters being used by [_____] are: [_____]. [The Government will configure the meter(s), which must be compatible with the existing system, using existing software. Contractor is to ensure that the meter(s) transmit the specified data to the DAS. The current meters being used by [_____] are: [_____].]

][2.1.5.10 Direct Digital Control System Interface

Provide all meters with the capability of providing pulse output to the DDC system provided in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

][2.1.5.11 Meter Setter

[Provide AWWA C800 [manufactured] meter setter with [a bypass,]inlet and

outlet valves.
]
[Provide a [_____] inch by-pass assembly[as shown on drawings] with the valve located[inside][outside] the vault.[Provide valve box for valve located outside of vault.]

]]2.1.5.12 Meter [Boxes] [Vaults]

Provide meter [boxes] [vaults] of sufficient size to completely enclose the meter and shutoff valve or service stop and in accordance with the details shown on the drawings. Provide a meter boxes or vaults with a height equal to the distance from invert of the service line to finished grade at the meter location.

2.1.5.12.1 Cast Iron

Provide ASTM A48/A48M, Class 25 cast iron meter box and lid. Provide a [round] lid [with precast holes for remote electronic meter reading modules] having the word "WATER" cast on the top surface.

[2.1.5.12.2 Precast Concrete Meter [Boxes] [Vaults]

Provide [ASTM C1433] [precast concrete meter boxes in accordance with Section 03 42 13.00 10 PLANT-PRECAST CONCRETE PRODUCTS FOR BELOW GRADE CONSTRUCTION.] precast concrete meter [boxes] [vaults] with ASTM A48/A48M, Class 25 cast iron lid. Provide a ASTM A48/A48M, Class 25 cast iron [with precast holes for remote electronic meter reading modules] [round] lid having the word "WATER" cast on it. Provide meter [boxes] [vaults] of sufficient size to completely enclose the meter and shutoff valve or service stop and in accordance with the details shown on the drawings.

[2.1.5.12.2.1 Vault Access Door

Provide a [single-leaf][double-leaf] cast-in [aluminum][painted steel] diamond-plate access door with the following dimensions:

Width: [_____] feet

Length: [_____] feet

Include [stainless steel spring][pneumatic] lift assist, type 316 stainless steel slam locking latch, automatic hold-open arm with a red release handle, and flush mounted retractable lifting handle. Door must have a minimum load rating for[AASHTO HS-20] [15,000 lbs] load.[Center door[over meter assembly][over ladder and aligned with interior wall].]

]2.1.5.12.2.2 Fittings

Provide flanged fittings for pipe 3 inches and larger.

2.1.5.12.2.3 Vault Valves

Provide [ball] [outside screw and yoke (OS&Y)] [butterfly] valves in meter vault.

][2.1.5.12.3 Plastic Meter Boxes

Provide manufactured plastic boxes [and lids] meeting the following requirements:

a. One-piece molded construction

b. Vertical load rating for medium duty use of [15,000 lbs][_____]

c. Ultraviolet (UV) exterior surface protection

d. White interior surface

[Provide a ASTM A48/A48M, Class 25 cast iron ring and [round] lid.

]]2.1.6 Backflow Preventers

Provide a [bronze] [cast iron] [ductile iron] AWWA C511 reduced pressure principle type backflow preventer meeting the following requirements:

a. Size: [_____]

[b. Maximum Rated Flow: [_____]

][c. Allowable Pressure Loss: [_____]

] d. Flanged [cast iron], [bronze] [brass] mounted gate valve

[e. Strainer of the same material as the backflow preventer

][f. Stainless steel alloys in accordance with ASTM A276/A276M, Type [304] [_____]

] [The particular make, model, and size of backflow preventers to be installed must be included in the latest edition of the List of Approved Backflow Prevention Assemblies issued by the FCCCHR List and be accompanied by a backflow certificate of full approval from FCCCHR List.]Select materials for piping, strainers, and valves used in assembly installation that are galvanically compatible. Materials joined, connected, or otherwise in contact are to have no greater than 0.25 V difference on the Anodic Index, unless separated by a dielectric type union or fitting.

2.1.6.1 Backflow Preventer Enclosure

Provide an [insulated] enclosure[with heat].

2.1.7 Disinfection

Chlorinating materials are to conform to: Chlorine, Liquid: AWWA B301; Hypochlorite, Calcium and Sodium: AWWA B300.

2.2 ACCESSORIES

2.2.1 Pipe Restraint

[2.2.1.1 Thrust Blocks

Use ASTM C94/C94M concrete having a minimum compressive strength of [2,500 psi] [_____] at 28 days[or use concrete of a mix not leaner than one part cement, two and one half parts sand, and five parts gravel, having the same minimum compressive strength].

~~][2.2.1.2 Precast Thrust Blocks~~

~~Provide precast concrete thrust blocks.~~

~~][2.2.1.3 Joint Restraint~~

~~Provide restrained joints in accordance with NFPA 24, Chapter 10[and in accordance with ASTM F1674].~~

~~Provide [mechanical joint restraint] [restraint devices with gripper wedges incorporated into a follower gland and specifically designed for the pipe material[and meeting the requirements of AWWA C110/A21.10]] [or metal harness fabricated by the pipe manufacturer].~~

~~]2.2.2 Protective Enclosures~~

~~Provide Freeze-Protection Enclosures that are insulated and designed to protect aboveground water piping, equipment, or specialties from freezing and damage, with heat source to maintain minimum internal temperature of [_____] degrees F when external temperatures reach as low as [_____] degree F.~~

~~2.2.2.1 Housing~~

~~Reinforced and insulated [aluminum] [or] [fiberglass] construction; with anchoring devices for attaching housing to concrete base, access doors with locking devices, sized to allow access and service of the protected unit, drain openings, and an electric heating cable or heater with self-limiting temperature control.~~

~~[2.2.3 Tapping Sleeves~~

~~Provide cast gray, ductile, malleable iron or stainless steel, split-sleeve type tapping sleeves of the sizes indicated for connection to existing main with flanged or grooved outlet, and with bolts, follower rings and gaskets on each end of the sleeve. Utilize similar metals for bolts, nuts, and washers to minimize the possibility of galvanic corrosion. Provide dielectric gaskets where dissimilar metals adjoin. Provide a tapping sleeve assembly with a maximum working pressure of [150] [_____] psi. Provide bolts with square heads and hexagonal nuts. Longitudinal gaskets and mechanical joints with gaskets as recommended by the manufacturer of the sleeve. When using grooved mechanical tee, utilize an upper housing with full locating collar for rigid positioning which engages a machine-cut hole in pipe, encasing an elastomeric gasket which conforms to the pipe outside diameter around the hole and a lower housing with positioning lugs, secured together during assembly by nuts and bolts as specified, pre-torqued to 50 foot-pound.~~

~~]2.2.4 Sleeve-Type Mechanical Couplings~~

~~Use couplings to join plain-end piping by compression of a ring gasket at each end of the adjoining pipe sections. The coupling consists of one middle ring flared or beveled at each end to provide a gasket seat; two follower rings; two resilient tapered rubber gaskets; and bolts and nuts to draw the follower rings toward each other to compress the gaskets. Provide true circular middle ring and the follower rings sections free from irregularities, flat spots, and surface defects; provide for confinement and compression of the gaskets.[For [ductile iron] [and] [PVC] pipe, the middle ring is cast-iron [or steel; and the follower rings~~

~~are malleable or ductile iron].][For steel piping, the middle ring is steel and the follower rings are steel or malleable iron.][Cast iron, ASTM A48/A48M not less than Class 25.] Malleable and ductile iron are to meet the requirements of ASTM A47/A47M and ASTM A536, respectively.[Steel is to have a strength not less than that of the pipe.] Use gaskets for resistance to set after installation and to meet the requirements specified for gaskets for mechanical joint in AWWA C111/A21.11. Provide track-head type bolts ASTM A307, Grade A, with nuts, ASTM A563, Grade A; or round-head square-neck type bolts, ASME B18.5.2.1M and ASME B18.5.2.2M with hex nuts, ASME B18.2.2. Provide 5/8 inch diameter bolts; minimum number of bolts for each coupling is [_____] [for [_____] inch pipe], [_____] [for [_____] inch pipe,] [and] [_____] [for [_____] inch pipe]. Shape bolt holes in follower rings to hold fast to the necks of the bolts used. Do not use mechanically coupled joints using a sleeve-type mechanical coupling as an optional method of jointing except where pipeline is adequately anchored to resist tension pull across the joint. Provide a tight flexible joint with mechanical couplings under reasonable conditions, such as pipe movements caused by expansion, contraction, slight settling or shifting in the ground, minor variations in trench gradients, and traffic vibrations. Match coupling strength to that of the adjoining pipeline.~~

~~2.2.5 Insulating Joints~~

~~Provide a rubber-gasketed insulating joint or dielectric coupling between pipe of dissimilar metals which will effectively prevent metal-to-metal contact between adjacent sections of piping.~~

~~[2.2.6 Bonded Joints~~

~~[Where indicated][For all ferrous pipe], provide a metallic bond at each joint, including joints made with flexible couplings, caulking, or rubber gaskets, of ferrous metallic piping to effect continuous conductivity. Provide Size 1/0 copper conductor thermal weld type bond wire designed for direct burial and shaped to stand clear of the joint.~~

~~]2.2.7 Dielectric Fittings~~

~~Install dielectric fittings between threaded ferrous and nonferrous metallic pipe, fittings and valves, except where corporation stops join mains to prevent metal-to-metal contact of dissimilar metallic piping elements and compatible with the indicated working pressure.~~

~~2.2.8 Tracer Wire for Nonmetallic Piping~~

~~Provide a continuous bare copper or aluminum wire not less than 0.10 inch in diameter in sufficient length over each separate run of nonmetallic pipe.~~

~~2.2.9 Water Service Line Appurtenances~~

~~2.2.9.1 Corporation Stops~~

~~Ground key type; lead-free bronze, ASTM B61 or ASTM B62; compatible with the working pressure of the system and solder-joint, or flared tube compression type joint. Threaded ends for inlet and outlet of corporation stops, AWWA C800; coupling nut for connection to flared copper tubing, ASME B16.26.~~

~~2.2.9.2 Curb or Service Stops~~

~~Ground key, round way, inverted key type; made of lead-free bronze, ASTM B61or ASTM B62; and compatible with the working pressure of the system. Provide compatible ends for connection to the service piping. Cast an arrow into body of the curb or service stop indicating direction of flow.~~

~~[2.2.9.3 Service Clamps~~

~~Provide single or double flattened strap type service clamps used for repairing damaged cast-iron, steel or PVC pipe with a pressure rating not less than that of the pipe being repaired. Provide clamps with a galvanized malleable-iron body with cadmium plated straps and nuts and a rubber gasket cemented to the body.~~

~~]2.2.9.4 Goosenecks~~

~~Manufacture goosenecks from Type K copper tubing; provide joint ends for goosenecks compatible with connecting to corporation stop and service line. [Where multiple gooseneck connections are required for an individual service, connect goosenecks to the service line through a compatible lead-free brass or bronze branch connection; the total clear area of the branches to be at least equal to the clear area of the service line.]~~

~~2.2.9.5 Curb Boxes~~

~~Provide a curb box for each curb or service stop manufactured from cast iron, size capable of containing the stop where it is used. Provide a round head. Cast the word "WATER" on the lid. Factory coat the box with a heavy coat of bituminous paint.~~

~~PART 3 EXECUTION~~

~~3.1 PREPARATION~~

~~3.1.1 Connections to Existing System~~

~~Perform all connections to the existing water system in the presence of the Contracting Officer.~~

~~3.1.2 Operation of Existing Valves~~

~~Do not operate valves within or directly connected to the existing water system unless expressly directed to do so by the Contracting Officer.~~

~~3.1.3 Earthwork~~

~~Perform earthwork operations in accordance with Section 31 00 00 EARTHWORK 31 23 00.00 20 EXCAVATION AND FILL.~~

~~3.2 INSTALLATION~~

~~Install all materials in accordance with the applicable reference standard, manufacturers instructions and as indicated herein.~~

~~3.2.1 Piping~~

~~3.2.1.1 General Requirements~~

~~Install pipe, fittings, joints and couplings in accordance with the applicable referenced standard, the manufacturer's instructions and as specified herein.~~

~~3.2.1.1.1 Termination of Water Lines~~

~~Terminate the work covered by this section at a point approximately 5 feet from the building, unless otherwise indicated.~~

~~Do not lay water lines in the same trench with gas lines, fuel lines, electric wiring, or any other utility. Do not install copper tubing in the same trench with ferrous piping materials. Where nonferrous metallic pipe (i.e., copper tubing) crosses any ferrous piping, provide a minimum vertical separation of 12 inches between pipes.~~

~~3.2.1.1.2 Pipe Laying and Jointing~~

~~Remove fins and burrs from pipe and fittings. Before placing in position, clean pipe, fittings, valves, and accessories, and maintain in a clean condition. Provide proper facilities for lowering sections of pipe into trenches. Under no circumstances is it permissible to drop or dump pipe, fittings, valves, or other water line material into trenches. Cut pipe cleanly, squarely, and accurately to the length established at the site and work into place without springing or forcing. Replace a pipe or fitting that does not allow sufficient space for installation of jointing material. Blocking or wedging between bells and spigots is not permitted. Lay bell-and-spigot pipe with the bell end pointing in the direction of laying. Grade the pipeline in straight lines; avoid the formation of dips and low points. Support pipe at the design elevation and grade. Secure firm, uniform support. Wood support blocking is not permitted. Lay pipe so that the full length of each section of pipe and each fitting rests solidly on the pipe bedding; excavate recesses to accommodate bells, joints, and couplings. Provide anchors and supports for fastening work into place. Make provision for expansion and contraction of pipelines. Keep trenches free of water until joints have been assembled. At the end of each work day, close open ends of pipe temporarily with wood blocks or bulkheads. Do not lay pipe when conditions of trench or weather prevent installation.[Provide a minimum of 2 1/2 feet depth of cover over top of pipe.]~~

~~3.2.1.1.3 Tracer Wire~~

~~Install a continuous length of tracer wire for the full length of each run of nonmetallic pipe. Attach wire to top of pipe in such manner that it will not be displaced during construction operations.~~

~~3.2.1.1.4 Connections to Existing Water Lines~~

~~Make connections to existing water lines after coordination with the facility and with a minimum interruption of service on the existing line. Make connections to existing lines under pressure in accordance with the recommended procedures of the manufacturer of the pipe being tapped and as indicated, except as otherwise specified, tap concrete pipe in accordance with AWWA M9 for tapping concrete pressure pipe.~~

All connections to NAVFAC Hawaii's potable water lines 12 inches in diameter and smaller using corporation stops or tapping sleeves and tapping valves are only to be made by NAVFAC Hawaii's forces. Coordinate this work, via the Contracting Officer, with NAVFAC Hawaii's and provide NAVFAC Hawaii, Utilities Department, PW65, telephone 473-2557, 14 calendar days advance notification of the date of connection. The Government will furnish, install and operate the tapping machine. Equipment necessary for the installation and operation of the tapping machine as well as necessary cutting blades will be provided by the Government. Disinfection of the tapping machine will be done by the Government. Provide [corporation stops,] [tapping sleeves and tapping valves,] and all other material, labor, and equipment necessary for the connection. Perform all earthwork and disinfection work at the connection prior to installation of the tapping machine by the Government. Perform the disinfection work in the presence of the PWC PEARL Utilities Department personnel. Provide all other connections, including wet tapping mains larger than 12 inches in diameter and installation of new pipe fittings in existing mains. Make connections to existing water lines in the presence of the NAVFAC Hawaii Utilities Department personnel. Provide NAVFAC Hawaii, Utilities Department, PW65, telephone 473-2557, 14 calendar days advance notification of the date of connection.

3.2.1.1.5 Sewer Manholes

No water piping is to pass through or come in contact with any part of a sewer manhole.

3.2.1.1.6 Water Piping Parallel With Sewer Piping

[Where the location of the water line is not clearly defined by dimensions on the drawings, do not lay water line closer than 10 feet, horizontally, from any sewer line.
]

a. Normal Conditions: Lay water piping at least 10 feet horizontally from sewer or sewer manhole whenever possible. Measure the distance from outside edge to outside edge of pipe or outside edge of manhole. When local conditions prevent horizontal separation install water piping in a separate trench with the bottom of the water piping at least 18 inches above the top of the sewer piping.

b. Unusual Conditions: When local conditions prevent vertical separation, construct sewer piping of AWWA compliant ductile iron water piping and perform hydrostatic sewer test, without leakage, prior to backfilling. When local conditions prevent vertical separation, test the sewer manhole in place to ensure watertight construction.

3.2.1.1.7 Water Piping Crossing Sewer Piping

[Provide at least 18 inches above the top (crown) of the sewer piping and the bottom (invert) of the water piping whenever possible. Measure the distance edge-to-edge. Where water lines cross under gravity sewer lines, construct sewer line of AWWA compliant ductile iron water piping with rubber-gasketed joints and no joint located within 10 feet, horizontally, of the crossing.][Lay water lines which cross sewer force mains and inverted siphons at least 2 feet above these sewer lines; when joints in the sewer line are closer than 3 feet horizontally from the water line relay the sewer line to ensure no joint closer than 3 feet.]

a. Normal Conditions: Provide a separation of at least 18 inches between

the bottom of the water piping and the top of the sewer piping in cases where water piping crosses above sewer piping.

b. Unusual Conditions: When local conditions prevent a vertical separation described above, construct sewer piping passing over or under water piping of AWWA compliant ductile iron water piping and perform hydrostatic sewer test, without leakage, prior to backfilling. Construct sewer crossing with a minimum 20 feet length of the AWWA compliant ductile iron water piping, centered at the point of the crossing so that joints are equidistant and as far as possible from the water piping. Protect water piping passing under sewer piping by providing a vertical separation of at least 18 inches between the bottom of the sewer piping and the top of the water piping; adequate structural support for the sewer piping to prevent excessive deflection of the joints and the settling on or damage to the water piping.

3.2.1.1.8 Penetrations

Provide ductile-iron or Schedule 40 steel wall sleeves for pipe passing through walls of valve pits and structures. Fill annular space between walls and sleeves with rich cement mortar. Fill annular space between pipe and sleeves with mastic.

3.2.1.1.9 Flanged Pipe

Only install flanged pipe aboveground or with the flanges in valve pits.

3.2.1.2 Ductile-Iron Piping

Unless otherwise specified, install pipe and fittings in accordance with the paragraph GENERAL REQUIREMENTS and with the requirements of AWWA C600 for pipe installation, joint assembly, valve-and-fitting installation, and thrust restraint.

a. Jointing: [Make push-on joints with the gaskets and lubricant specified for this type joint; assemble in accordance with the applicable requirements of AWWA C600 and AWWA M41 for joint assembly.] [Make mechanical joints with the gaskets, glands, bolts, and nuts specified for this type joint; assemble in accordance with the applicable requirements of AWWA C600 and AWWA M41 for joint assembly and the recommendations of Appendix A to AWWA C111/A21.11.] [Make flanged joints with the gaskets, bolts, and nuts specified for this type joint. Make flanged joints up tight; avoid undue strain on flanges, fittings, valves, and other[equipment and] accessories. Align bolt holes for each flanged joint. Use full size bolts for the bolt holes; use of undersized bolts will not be permitted. Do not allow adjoining flange faces to be out of parallel to such degree that the flanged joint cannot be made watertight without overstraining the flange. When flanged pipe or fitting has dimensions that do not allow the making of a flanged joint as specified, replace it. [Use set screw flanges to make flanged joints where conditions prevent the use of full-length flanged pipe and assemble in accordance with the recommendations of the set screw flange manufacturer. During installation of set screw gasket provide for confinement and compression of gasket when joint to adjoining flange is made.]] [Assemble joints made with sleeve-type mechanical couplings in accordance with the recommendations of the coupling manufacturer.] Make [grooved] [and] [shouldered] type joints with the couplings

previously specified for this type joint connecting pipe with the [grooved] [or] [shouldered] ends specified for this type joint; assemble in accordance with the recommendations of the coupling manufacturer.[Groove pipe in the field only with groove cutting equipment designed especially for the purpose and produced by a manufacturer of grooved joint couplings; secure approval for field-cut grooves before assembling the joint.][Make insulating joints with the gaskets, sleeves, washers, bolts, and nuts previously specified for this type joint. Assemble insulating joints as specified for flanged joints, except that bolts with insulating sleeves are to be full size for the bolt holes. Ensure that there is no metal-to-metal contact between dissimilar metals after the joint has been assembled.]

b. Allowable Deflection: Follow AWWA C600 and AWWA M41 for the maximum allowable deflection. If the alignment requires deflection in excess of the above limitations, provide special bends or a sufficient number of shorter lengths of pipe to achieve angular deflections within the limit set forth.

[c. Exterior Protection: Completely encase buried ductile iron pipelines using [Method A or B] [Method C], with polyethylene film, in accordance with AWWA C105/A21.5.

]

3.2.1.3 PVC and PVCO Water Main Pipe

Unless otherwise specified, install pipe and fittings in accordance with the paragraph GENERAL REQUIREMENTS and with the requirements of AWWA C605 for laying of pipe, joining PVC pipe to fittings and accessories, setting of fire hydrants, valves, and fittings; and with the recommendations for pipe joint assembly and appurtenance installation in AWWA M23, Chapter 7, "Installation."

a. Jointing: Make push-on joints with the elastomeric gaskets specified for this type joint, using either elastomeric-gasket bell-end pipe or elastomeric-gasket couplings. For pipe-to-pipe push-on joint connections, use only pipe with push-on joint ends having factory-made bevel; for push-on joint connections to metal fittings, valves, and other accessories, cut spigot end of pipe off square and re-bevel pipe end to a bevel approximately the same as that on ductile-iron pipe used for the same type of joint. Use a lubricant recommended by the pipe manufacturer for push-on joints. Assemble push-on joints for pipe-to-pipe joint connections in accordance with the requirements of AWWA C605 for laying the pipe and the recommendations in AWWA M23, Chapter 7, "Installation," for pipe joint assembly. Assemble push-on joints for connection to fittings, valves, and other accessories in accordance with the requirements of AWWA C605 for joining PVC pipe to fittings and accessories and with the requirements of AWWA C600 for joint assembly. Make compression-type joints/mechanical joints with the gaskets, glands, bolts, nuts, and internal stiffeners previously specified for this type joint; assemble in accordance with the requirements of AWWA C605 for joining PVC pipe to fittings and accessories, with the requirements of AWWA C600 for joint assembly, and with the recommendations of Appendix A to AWWA C111/A21.11. Cut off spigot end of pipe for compression-type joint/mechanical-joint connections and do not re-bevel. Assemble joints made with sleeve-type mechanical couplings in accordance with the recommendations of the coupling manufacturer using internal stiffeners as previously specified for compression-type joints.

b. Joint Offset: Construct joint offset in accordance AWWA C605. Do not exceed the minimum longitudinal bending as indicated by AWWA C605.

c. Fittings: Install in accordance with AWWA C605.

3.2.1.4 Polyethylene (PE) Piping

Install PE pipes in accordance with AWWA M55 and ASTM D2774.

3.2.1.5 Fiberglass Piping

Install fiberglass piping in accordance with AWWA M45, ASTM D3839 and the manufacturer's installation instructions.

3.2.1.5.1 RTRP I Jointing

Assemble the pipe in conformance with the manufacturer's written instruction and installation procedures. Prepare field bonding and curing of joints as specified by the pipe manufacturer (several pipe joints having interference-fit type couplings may be bonded and cured simultaneously. The pipe is not to be moved and additional joints are not to be made until the previously bonded joints are completely cured. Joints not having interference-fit type coupling are to be fitted with a clamp that will hold the joint rigidly in place until the joint cement has completely cured.

Provide a protective material on the inner surface of the clamp to prevent damage to the plastic pipe when the clamp is tightened in place. Provide a manufacturer recommended device or method to determine when the joint is pulled against the pipe stop. Provide a gauge from the pipe manufacturer to measure the diameter of the spigot ends to ensure the diameter conforms to the tolerances specified by the manufacturer. Gauge all pipe ends. At any ambient temperatures, cure field bonded epoxy-cemented joints with a self-regulating, thermostatically temperature controlled, electrical heating blanket for the time and temperature recommended by the manufacturer for the size and type of joint, or by an alternate heating method recommended by the manufacturer. Do not move the joint sections during heating, or until the joint has cooled to ambient temperature.

3.2.1.5.2 RTRP II Jointing

Utilize a reinforced overlay joint to join sections together through a placement of layers of reinforcement fiberglass roving, mat, tape or fabric saturated with compatible catalyzed resin.

3.2.1.5.3 RPMP Jointing

Utilize bell and spigot gasket-sealing couplings to connect pipes. Lubricate the spigot prior to push-together assembly.

3.2.1.5.4 Fittings and Specials for RTRP and RPMP Pipe

Assemble metal to RTRP and RPMP pipe connections by bolting steel flanges to RTRP and RPMP pipe flanges. Utilize cast-iron fittings with gasket bell or mechanical joint with RTRP if pipe has cast iron outside diameter. Steel flanges are to be flat-faced type. Use spacer rings to provide a flat-face seat for RTRP and RPMP pipe flanges where raised-face steel flanges are used. Provide a full-face Buna "N" gasket 1/8 inch thick with a shore hardness of 50-60 between all flanged connections. The

RTRP and RPMP pipe flange are to have raised sealing rings. Use flat washers under all nuts and bolts on RTRP and RPMP pipe flanges. Torque non-corrosive bolts and nuts to not more than 100 foot pounds. Do not direct bury flanges. Provide a concrete pit for all flanged connections.

3.2.1.5.5 Allowable Offsets

a. RTRP: Comply with manufacturer's recommendations for the maximum offset in alignment between adjacent pipe joints but do not exceed 5 degrees.

b. RPMP: Comply with manufacturer's recommendations for pipe with bell and spigot rubber gasket joints. Maximum allowable deflections from a straight line or grade is 4 degrees and determined by the diameter, unless a lesser amount is recommended by the manufacturer. Form short-radius curves and closures with short lengths of pipe or fabricated specials specified.

3.2.1.6 [Concrete Pressure Pipe] [PCCP] [RCCP] Piping

Except as otherwise specified in the following subparagraphs, install pipe and fittings in accordance with the paragraph GENERAL REQUIREMENTS, the laying and joining requirements specified in AWWA M9; and with the recommendations given in AWWA M9 "Design of Thrust Restraints for Buried Pipe".

a. Jointing: Make joints with the gaskets specified for concrete pipe joints, using a lubricant recommended by the manufacturer. Assemble joints in accordance with the joining requirements specified in AWWA M9 and with the recommendations given for laying the pipe in AWWA M9, chapter entitled "Installation by Trenching or Tunneling--Methods and Equipment." Acceptable joint types are bell and spigot, structural welded, skip welded, clamp type harness, bell bolt harness and snap ring harnesses. Prior to backfilling, wrap joints with a joint wrapper and fill with grout as recommended by the manufacturer. For pipe large enough to accommodate a worker, point the interior joint space with a stiff mixture of portland cement and smooth finish with a hand trowel.

b. Allowable Offsets: To the extent possible, follow the manufacturer's laying schedule, which will indicate the use and location of joint gaps, spacers, beveled joints, short pipe lengths, fabricated specials and beveled adapters. Unless a lesser amount is recommended by the manufacturer, the maximum allowable offset in a joint is 5 degrees.

3.2.1.7 Steel Piping

Unless otherwise specified, install pipe and fittings in accordance with AWWA C604 and AWWA M11, Chapter 12, "Transportation, Installation, and Testing." [Apply protective coating for aboveground piping as specified in Section [_____].]

a. Jointing: Make rubber-gasketed bell-and-spigot joints with the gaskets previously specified for this type joint, using a lubricant recommended by the pipe manufacturer; assemble in accordance with the recommendations of the pipe manufacturer.[Make welded joints in accordance with AWWA C206 and with the recommendations given for installation of pipe in AWWA M11, Chapter 12, "Transportation, Installation, and Testing."] Assemble joints made with sleeve-type

mechanical couplings in accordance with the recommendations of the coupling manufacturer.[Make flanged joints with the gaskets, bolts, and nuts specified for this type joint. Make flanged joints up tight; avoid undue strain on flanges, fittings, valves, and other [equipment and] accessories. Align bolt holes for each flanged joint. Use full-size bolts for the bolt holes; use of undersized bolts is not permitted. Do not allow adjoining flange faces to be out of parallel to such degree that the flanged joint cannot be made watertight without straining the flange. Replace flanged pipe or fittings with dimensions that do not allow the making of a flanged joint as specified.][[Make grooved type joints with the couplings specified for this type joint connecting pipe with roll-grooved ends or pipe with welded-on cut-grooved adapters, each with dimensions as previously specified for this type joint. Groove pipe ends in the field only with manufacturer recommended groove rolling equipment and manufacturer recommended groove adapters in the field only with manufacturer recommended groove cutting equipment; use groove rolling and groove cutting equipment especially for the purpose and produced by a manufacturer of grooved joint couplings. Obtain approval for field-cut grooves before assembling the joint.][Make shouldered type joints with the couplings specified for this type joint connecting pipe with the shouldered ends specified for this type joint.] Assemble [grooved] [and] [shouldered] type joints in accordance with the recommendations of the coupling manufacturer.][Make insulating joints with the gaskets, sleeves, washers, bolts, and nuts specified for this type joint. Assemble insulating joints as specified for flanged joints, except that bolts with insulating sleeves are to be full size for the bolt holes. Ensure that there is no metal-to-metal contact between dissimilar metals after the joint has been assembled.] Finish joints on piping with cement-mortar lining[and on piping with cement-mortar coating] as specified in Appendix on Field Joints in AWWA C205.[Finish joints on piping with [coal-tar enamel] [or] [coal-tar epoxy] coating by cleaning, priming, coating, and wrapping with a cold-applied tape coating matching the requirements of, and applied in accordance with AWWA C209.]

b. Allowable Offsets: For pipe with bell-and-spigot rubber-gasket joints, maximum allowable deflections from a straight line or grade, as required by vertical curves, horizontal curves, or offsets is 5 degrees unless a lesser amount is recommended by the manufacturer. Form short-radius curves and closures with short lengths of pipe or fabricated specials specified.

c. Cement Mortar Lining: AWWA C205, shop applied.

3.2.1.8 Metallic Piping for Service Lines

Install pipe and fittings in accordance with the paragraph GENERAL REQUIREMENTS and with the applicable requirements of AWWA C600 for pipe installation, unless otherwise specified.

3.2.1.8.1 Screwed Joints

Make screwed joints up tight with a stiff mixture of graphite and oil, inert filler and oil, or graphite compound; apply to male threads only or with PTFE Tape, for use with threaded pipe. Threads are to be full cut; do not leave more than three threads on the pipe exposed after assembling the joint.

~~3.2.1.8.2 Joints for Copper Tubing~~

~~Cut copper tubing with square ends; remove fins and burrs. Replace dented, gouged, or otherwise damaged tubing with undamaged tubing. Make solder joints using ASTM B32, 95-5 tin-antimony or Grade Sn96 solder. Use solder and flux containing less than 0.2 percent lead. Before making joint, clean ends of tubing and inside of fitting or coupling with wire brush or abrasive. Apply a rosin flux to the tubing end and on recess inside of fitting or coupling. Insert tubing end into fitting or coupling for the full depth of the recess and solder. For compression joints on flared tubing, insert tubing through the coupling nut and flare tubing.~~

~~3.2.1.8.3 Flanged Joints~~

~~Make flanged joints up tight, avoid undue strain on flanges, valves, fittings, and accessories.~~

~~3.2.1.8.4 Protection of Buried Steel Service Line Piping~~

~~[Unless otherwise specified,] prepare, prime, and coat exterior surface of zinc-coated steel pipe and associated fittings to be buried with hot-applied coal-tar enamel with a bonded[single layer of felt wrap in accordance with AWWA C203][double felt wraps in accordance with AWWA C203]. For the felt wrap material, use fibrous-glass mat as specified in AWWA C203; use of asbestos felt will not be permitted. Use solvent wash only to remove oil, grease, and other extraneous matter from zinc-coated pipe and fittings.~~

~~3.2.1.9 Plastic Service Piping~~

~~Install pipe and fittings in accordance with the paragraph GENERAL REQUIREMENTS and with the applicable requirements of ASTM D2774 [and ASTM D2855], unless otherwise specified. Handle solvent cements used to join plastic piping in accordance with ASTM F402.~~

~~3.2.1.9.1 Jointing~~

~~[Make solvent-cemented joints for PVC piping using the solvent cement previously specified for this material; assemble joints in accordance with ASTM D2855.] Make plastic pipe joints to other pipe materials in accordance with the recommendations of the plastic pipe manufacturer.~~

~~3.2.1.9.2 Plastic Pipe Connections to Appurtenances~~

~~Connect plastic service lines to corporation stops and gate valves in accordance with the recommendations of the plastic pipe manufacturer.~~

~~3.2.1.10 Trenchless Piping~~

~~3.2.1.10.1 Butt Fusion~~

~~Fusible pipe will be fused by qualified fusion technicians, as required by manufacturer of the fusion equipment. Record and log each fusion joint by an electronic monitoring device (data logger) connected to the fusion machine. Log fusion data and create Post-Construction Fusion Report with software specifically developed for the pipe material being fused. Software must record the parameters required by the fusion equipment manufacturer and these specifications. Manual log data not logged by the data logger and be included in the Post-Construction Fusion Report.~~

Assemble fusible PVC and PE pipe lengths in the field with butt-fused joints. Follow the manufacturer's fusion equipment procedures.

a. Install butt fused PE Pipe in accordance with ASTM F1962.

b. For butt fused PVC Pipe provide joints meeting the requirements of ASTM F1674.

3.2.1.10.2 Post-Construction Fusion Report

Include the following data for each fusible connection in the report:

a. Pipe Size and Thickness
b. Machine Size
c. Fusion Technician Identification
d. Job Identification
e. Fusion Joint Number
f. Fusion, Heating, and Drag Pressure Settings
g. Heat Plate Temperature
h. Time Stamp
i. Heating and Cool Down Time of Fusion
j. Ambient Temperature

3.2.1.10.3 Installation Ductile Iron Ball and Socket Joint

Install pipe and fittings in accordance with AWWA C600 and AWWA M41 for pipe installation, joint assembly, and thrust restraint.

a. Allowable Deflection: Meet the applicable requirements of AWWA C600, AWWA M41 and in accordance with pipe manufacturer's instructions for the maximum allowable deflection.

[b. Exterior Protection: Completely encase buried ductile iron pipelines using Method A or B, with polyethylene film, in accordance with AWWA C105/A21.5.

]3.2.1.11 Fire Protection Service Lines for Sprinkler Supplies

Connect water service lines used to supply building sprinkler systems for fire protection to the water main in accordance with NFPA 24.

3.2.1.12 Water Service Piping

3.2.1.12.1 Location

Connect water service piping to the building service where the building service has been installed. Where building service has not been installed, terminate water service lines approximately 5 feet from the building line at the points indicated; close such water service lines with plugs or caps.

3.2.1.12.2 Water Service Line Connections to Water Mains

[Connect [[_____] inch] water service lines to the main [by a corporation stop and gooseneck and install a service stop below the frostline][as indicated].][Connect water service lines 2 inch size to the main[with a rigid connection or a corporation stop and gooseneck and install a gate valve on service line below the frostline][as indicated].][Connect [[_____] inch] water service lines to the main [with a rigid connection

and install a gate valve on service line below the frostline][as indicated].][Connect water service lines to ductile-iron water mains in accordance with AWWA C600 for service taps.][Connect water service lines to PVC water mains in accordance with UBPPA UNI-PUB-08 and the recommendations of AWWA M23, Chapter 9, "Service Connections."][Connect water service lines to concrete water mains in accordance with the recommendations of AWWA M9, "Tapping Concrete Pressure Pipe."]Connect water service lines to steel water mains in accordance with the recommendations of the steel water main pipe manufacturer and with the recommendations for special and valve connections and other appurtenances in AWWA M11, Chapter 13, "Supplementary Design Data and Details."

[3.2.2 Railroad Right-of-Way

Install piping passing under the right-of-way of a commercial railroad in accordance with the specifications for pipelines conveying nonflammable substances in Chapter 1, Part 5, of the AREMA Eng Man.[For PVC water main pipe, also install in accordance with the recommendations of AWWA M23 for installation of casings.]

]3.2.3 Meters

Install meters and meter [boxes] [vaults] at the locations shown on the drawings. Center meters in the [boxes] [vaults] to allow for reading and ease of removal or maintenance. Set top of box or vault at finished grade.

3.2.4 Backflow Preventers

Install backflow preventers of type, size, and capacity indicated a minimum of 12 inch and a maximum of 36 inch above concrete base. Include valves and test cocks. Install according to the manufacturers requirements and the requirements of plumbing and health department and authorities having jurisdiction. Support NPS 2 1/2 inch and larger backflow preventers, valves, and piping near floor with 12 inch minimum air gap, and on concrete piers or steel pipe supports. Do not install backflow preventers that have a relief drain in vault or in other spaces subject to flooding. Do not install by-pass piping around backflow preventers.

3.2.4.1 Backflow Preventer Enclosure

Install a level concrete base with top of concrete surface approximately [2 inches] [[_____] inches] above grade. Install protective enclosure over valve and equipment. Anchor protective enclosure to concrete base.

3.2.5 Disinfection

[Disinfection of systems supplying non-potable water is not required.
]

Prior to disinfection, provide disinfection procedures, proposed neutralization and disposal methods of waste water from disinfection as part of the disinfection submittal. Disinfect new water piping and existing water piping affected by Contractor's operations in accordance with AWWA C651. Disinfect new water piping using the AWWA C651 [continuous-feed method of chlorination][_____].[Ensure a free chlorine residual of not less than 10 parts per million after 24 hour holding period and prior to performing bacteriological tests.]

~~3.2.6 Flushing~~

~~Perform bacteriological tests prior to flushing. Flush solution from the systems with domestic water until maximum residual chlorine content is within the range of 0.2 to 0.5 parts per million, the residual chlorine content of the distribution system, or acceptable for domestic use. Use AWWA C655 neutralizing chemicals.~~

~~3.2.7 Pipe Restraint~~

~~3.2.7.1 Concrete Thrust Blocks~~

~~Install concrete thrust blocks where indicated.~~

~~3.2.7.2 Restrained Joints~~

~~Install restrained joints in accordance with [the manufacturer's instructions] [NFPA 24] [_____] where indicated. [For metal harness use tie rods and clamps as shown in NFPA 24.] [Provide structural welded, skip welded, clamp type harness, bell bolt harness, snap ring harness for pipe anchorage.] [Provide metal harness fabricated by the pipe manufacturer and furnished with the pipe.]~~

~~3.2.8 Valves~~

~~3.2.8.1 Gate Valves~~

~~Install gate valves, AWWA C500 and UL 262, in accordance with the requirements of AWWA C600 for valve-and-fitting installation and with the recommendations of the Appendix ("Installation, Operation, and Maintenance of Gate Valves") to AWWA C500. Install gate valves, AWWA C509 or AWWA C515, in accordance with the requirements of AWWA C600 for valve-and-fitting installation and with the recommendations of the Appendix ("Installation, Operation, and Maintenance of Gate Valves") to AWWA C509 or AWWA C515. Install gate valves on PVC and PVCO water mains in accordance with the recommendations for appurtenance installation in AWWA M23, Chapter 7, "Installation." Make and assemble joints to gate valves as specified for making and assembling the same type joints between pipe and fittings.~~

~~3.2.8.2 Check Valves~~

~~Install check valves in accordance with the applicable requirements of AWWA C600 for valve-and-fitting installation [, except as otherwise indicated]. Make and assemble joints to check valves as specified for making and assembling the same type joints between pipe and fittings.~~

~~3.2.8.3 Air Release, Air/Vacuum, and Combination Air Valves~~

~~Install pressure vacuum assemblies of type, size, and capacity indicated. Include valves and test cocks. Install according to the requirements of plumbing and health department and authorities having jurisdiction. Do not install pressure vacuum breaker assemblies in vault or other space subject to flooding.~~

~~3.2.9 Blowoff Valve Assemblies~~

~~Install blowoff valve assemblies as indicated on the drawings or in accordance with the manufactures recommendations. Install discharge fitting on the end of riser pipe to direct the flow of water so as to~~

minimize damage to surrounding areas.

3.2.10 Fire Hydrants

Install fire hydrants[, except for metal harness,] in accordance with AWWA C600 for fire hydrant installation and as indicated. Make and assemble joints as specified for making and assembling the same type joints between pipe and fittings.[Provide metal harness as specified under pipe anchorage requirements for the respective pipeline material to which fire hydrant is attached.] Install fire hydrants with the 4 1/2 inch connections facing the adjacent paved surface. If there are two paved adjacent surfaces, install fire hydrants with the 4 1/2 inch connection facing the paved surface where the connecting main is located.

3.3 FIELD QUALITY CONTROL

3.3.1 Tests

Notify the Contracting Officer a minimum of five days in advance of hydrostatic testing. Coordinate the proposed method for disposal of waste water from hydrostatic testing. Perform field tests, and provide labor, equipment, and incidentals required for testing[, except that water needed for field tests will be furnished as set forth in paragraph AVAILABILITY AND USE OF UTILITY SERVICES in Section 01 50 00 TEMPORARY CONSTRUCTION FACILITIES AND CONTROLS]. Provide documentation that all items of work have been constructed in accordance with the Contract documents.

3.3.1.1 Hydrostatic Test

Test the water system in accordance with the applicable AWWA standard specified below. [Where water mains provide fire service, test in accordance with the special testing requirements given in the paragraph SPECIAL TESTING REQUIREMENTS FOR FIRE SERVICE.]Test ductile-iron water mains in accordance with the requirements of AWWA C600 for hydrostatic testing. The amount of leakage on ductile-iron pipelines with mechanical-joints [or push-on joints] is not to exceed the amounts given in AWWA C600; no leakage will be allowed at joints made by any other methods. Test PVC and PVCO plastic water systems made with PVC pipe in accordance with the requirements of AWWA C605 for pressure and leakage tests. The amount of leakage on pipelines made of PVC water main pipe is not to exceed the amounts given in AWWA C605, except that at joints made with sleeve-type mechanical couplings, no leakage will be allowed. Test concrete water mains in accordance with the recommendations in AWWA M9, "Hydrostatic Testing and Disinfection of Mains." The amount of leakage on concrete pipelines is not to exceed 20 gallons per 24 hours per inch of pipe diameter per mile of pipeline. Test steel water mains in accordance with applicable requirements of AWWA C600 for hydrostatic testing. The amount of leakage on steel pipelines with rubber-gasketed bell-and-spigot joints is not to exceed 20 gallons per 24 hours per inch of pipe diameter per mile of pipeline; no leakage will be allowed at joints made by any other method. To stop leakage, repair welded joints only by welding. Test water service lines in accordance with requirements of AWWA C600 for hydrostatic testing. No leakage will be allowed at copper pipe joints, copper tubing joints (soldered, compression type, brazed), plastic pipe joints, flanged joints, [and]screwed joints. Do not backfill utility trench or begin testing on any section of a pipeline where concrete thrust blocks have been provided until at least [7][_____] days after placing of the concrete.

~~3.3.1.2 Hydrostatic Sewer Test~~

~~The hydrostatic pressure sewer test will be performed in accordance with the applicable AWWA standard for the piping material or AWWA C600[with a minimum test pressure of [_____]].~~

~~3.3.1.3 Leakage Test~~

~~For leakage test, use a hydrostatic pressure not less than the maximum working pressure of the system. Leakage test may be performed at the same time and at the same test pressure as the pressure test.~~

~~For PE perform leak testing in accordance with ASTM F2164.~~

~~3.3.1.4 Bacteriological Testing~~

~~Perform bacteriological tests in accordance with AWWA C651 [Option A][Option B].[For new water mains use Option A and obtain two sets of samples for coliform analysis, each sample being collected at least 16 hours apart. Take samples every 1,200 ft plus one set from the end of the line and at least one from each branch greater than one pipe length.] Analyze samples by a certified laboratory, and submit the results of the bacteriological samples.~~

~~3.3.1.5 Backflow Preventer Tests~~

~~After installation conduct Backflow Preventer Tests and provide test reports verifying that the installation meets the FCCCHR Manual Standards.~~

~~3.3.1.6 Special Testing Requirements for Fire Service~~

~~Test water mains and water service lines providing fire service or water and fire service in accordance with NFPA 24. The additional water added to the system must not exceed the limits given in NFPA 24~~

~~3.3.1.7 Tracer Wire Continuity Test~~

~~Test tracer wire for continuity after service connections have been completed and prior to final pavement or restoration. Verify that tracer wire is locatable with electronic utility locating equipment. Repair breaks or separations and re-test for continuity.~~

~~3.4 SYSTEM STARTUP~~

~~Water mains and appurtenances must be completely installed, disinfected, flushed, and satisfactory bacteriological sample results received prior to permanent connections being made to the active distribution system. Obtain approval by the Contracting Officer prior to the new water piping being placed into service.~~

~~3.5 CLEANUP~~

~~Upon completion of the installation of water lines and appurtenances, remove all debris and surplus materials resulting from the work.~~

~~-- End of Section --~~PART 1 GENERAL

See attached American Water Military Services Specification after this section.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

-- End of Section --

SECTION 33 30 00

SANITARY SEWERAGE
05/18

~~PART 1 GENERAL~~

~~1.1 REFERENCES~~

~~The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.~~

~~AMERICAN CONCRETE PIPE ASSOCIATION (ACPA)~~

~~ACPA 01-102~~	~~(2000) Concrete Pipe Handbook~~
~~ACPA 01-103~~	~~(2000) Concrete Pipe Installation Manual~~

~~AMERICAN RAILWAY ENGINEERING AND MAINTENANCE-OF-WAY ASSOCIATION (AREMA)~~

~~AREMA Eng Man~~	~~(2017) Manual for Railway Engineering~~

~~AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)~~

~~ASME B1.20.1~~	~~(2013; R 2018) Pipe Threads, General Purpose (Inch)~~
~~ASME B1.20.2M~~	~~(2006; R 2011) Pipe Threads, 60 Deg. General Purpose (Metric)~~
~~ASME B16.1~~	~~(2015) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250~~
~~ASME B18.2.2~~	~~(2015) Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)~~
~~ASME B18.5.2.1M~~	~~(2006; R 2011) Metric Round Head Short Square Neck Bolts~~
~~ASME B18.5.2.2M~~	~~(1982; R 2010) Metric Round Head Square Neck Bolts~~

~~AMERICAN WATER WORKS ASSOCIATION (AWWA)~~

~~AWWA C104/A21.4~~	~~(2016) Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water~~
~~AWWA C105/A21.5~~	~~(2018) Polyethylene Encasement for Ductile-Iron Pipe Systems~~
~~AWWA C110/A21.10~~	~~(2012) Ductile-Iron and Gray-Iron Fittings for Water~~
~~AWWA C111/A21.11~~	~~(2017) Rubber-Gasket Joints for~~

	Ductile-Iron Pressure Pipe and Fittings
AWWA C115/A21.15	(2020) Flanged Ductile-Iron Pipe With Ductile-Iron or Gray-Iron Threaded Flanges
AWWA C151/A21.51	(2017) Ductile-Iron Pipe, Centrifugally Cast
AWWA C153/A21.53	(2019) Ductile-Iron Compact Fittings for Water Service
AWWA C302	(2016) Reinforced Concrete Pressure Pipe, Noncylinder Type
AWWA C600	(2017) Installation of Ductile-Iron Mains and Their Appurtenances
AWWA C605	(2014) Underground Installation of Polyvinyl Chloride (PVC) and Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe and Fittings
AWWA C606	(2015) Grooved and Shouldered Joints
AWWA C900	(2016) Polyvinyl Chloride (PVC) Pressure Pipe, and Fabricated Fittings, 4 In. Through 60 In. (100 mm Through 1,500 mm)
AWWA M9	(2008; Errata 2013) Manual: Concrete Pressure Pipe

ASTM INTERNATIONAL (ASTM)

ASTM A47/A47M	(1999; R 2018; E 2018) Standard Specification for Ferritic Malleable Iron Castings
ASTM A48/A48M	(2003; R 2016) Standard Specification for Gray Iron Castings
ASTM A123/A123M	(2017) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A307	(2014; E 2017) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A536	(1984; R 2019; E 2019) Standard Specification for Ductile Iron Castings
ASTM A563	(2015) Standard Specification for Carbon and Alloy Steel Nuts
ASTM A563M	(2007; R 2013) Standard Specification for Carbon and Alloy Steel Nuts (Metric)
ASTM A746	(2018) Standard Specification for Ductile Iron Gravity Sewer Pipe

~~ASTM C12~~	~~(2017) Standard Practice for Installing Vitrified Clay Pipe Lines~~
~~ASTM C14~~	~~(2020) Standard Specification for Concrete Sewer, Storm Drain, and Culvert Pipe~~
~~ASTM C14M~~	~~(2020) Standard Specification for Concrete Sewer, Storm Drain, and Culvert Pipe (Metric)~~
~~ASTM C33/C33M~~	~~(2018) Standard Specification for Concrete Aggregates~~
~~ASTM C76~~	~~(2020) Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe~~
~~ASTM C76M~~	~~(2020) Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe (Metric)~~
~~ASTM C94/C94M~~	~~(2020) Standard Specification for Ready-Mixed Concrete~~
~~ASTM C150/C150M~~	~~(2020) Standard Specification for Portland Cement~~
~~ASTM C260/C260M~~	~~(2010a; R 2016) Standard Specification for Air-Entraining Admixtures for Concrete~~
~~ASTM C270~~	~~(2019) Standard Specification for Mortar for Unit Masonry~~
~~ASTM C361~~	~~(2016) Standard Specification for Reinforced Concrete Low-Head Pressure Pipe~~
~~ASTM C361M~~	~~(2016) Standard Specification for Reinforced Concrete Low-Head Pressure Pipe (Metric)~~
~~ASTM C425~~	~~(2004; R 2013) Standard Specification for Compression Joints for Vitrified Clay Pipe and Fittings~~
~~ASTM C443~~	~~(2020) Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets~~
~~ASTM C443M~~	~~(2020) Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets (Metric)~~
~~ASTM C478~~	~~(2018) Standard Specification for Circular Precast Reinforced Concrete Manhole Sections~~
~~ASTM C478M~~	~~(2018) Standard Specification for Precast Reinforced Concrete Manhole Sections~~

	~~(Metric)~~
~~ASTM C700~~	~~(2013) Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated~~
~~ASTM C828~~	~~(2011) Low-Pressure Air Test of Vitrified Clay Pipe Lines~~
~~ASTM C923~~	~~(2008; R 2013; E 2016) Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals~~
~~ASTM C923M~~	~~(2008b; R 2013) Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals (Metric)~~
~~ASTM C969~~	~~(2019) Standard Practice for Infiltration and Exfiltration Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines~~
~~ASTM C969M~~	~~(2019) Standard Practice for Infiltration and Exfiltration Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines (Metric)~~
~~ASTM C972~~	~~(2000; R 2011) Compression-Recovery of Tape Sealant~~
~~ASTM C990~~	~~(2009; R 2014) Standard Specification for Joints for Concrete Pipe, Manholes and Precast Box Sections Using Preformed Flexible Joint Sealants~~
~~ASTM C990M~~	~~(2009; R 2014) Standard Specification for Joints for Concrete Pipe, Manholes and Precast Box Sections Using Preformed Flexible Joint Sealants (Metric)~~
~~ASTM C1214~~	~~(2013) Standard Test Method for Concrete Pipe Sewerlines by Negative Air Pressure (Vacuum) Test Method~~
~~ASTM C1214M~~	~~(2013) Standard Test Method for Concrete Pipe Sewerlines by Negative Air Pressure (Vacuum) Test Method (Metric)~~
~~ASTM C1227~~	~~(2013) Standard Specification for Precast Concrete Septic Tanks~~
~~ASTM C1244~~	~~(2011; R 2017) Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill~~
~~ASTM C1244M~~	~~(2011; R 2017) Standard Test Method for Concrete Sewer Manholes by the Negative~~

	~~Air Pressure (Vacuum) Test Prior to Backfill (Metric)~~
~~ASTM C1644~~	~~(2006; R 2017) Standard Specification for Resilient Connectors Between Reinforced Concrete On-Site Wastewater Tanks and Pipes~~
~~ASTM D412~~	~~(2016) Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension~~
~~ASTM D624~~	~~(2000; R 2020) Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers~~
~~ASTM D1784~~	~~(2020) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds~~
~~ASTM D1785~~	~~(2015; E 2018) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120~~
~~ASTM D2241~~	~~(2015) Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)~~
~~ASTM D2321~~	~~(2020) Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications~~
~~ASTM D2412~~	~~(2011) Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading~~
~~ASTM D2464~~	~~(2015) Standard Specification for Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80~~
~~ASTM D2466~~	~~(2017) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40~~
~~ASTM D2467~~	~~(2015) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80~~
~~ASTM D2996~~	~~(2017) Standard Specification for Filament-Wound "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe~~
~~ASTM D2997~~	~~(2015) Centrifugally Cast "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe~~
~~ASTM D3034~~	~~(2016) Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and~~

	~~Fittings~~
~~ASTM D3139~~	~~(2019) Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals~~
~~ASTM D3212~~	~~(2007; R 2020) Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals~~
~~ASTM D3262~~	~~(2020) "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer Pipe~~
~~ASTM D3350~~	~~(2012) Polyethylene Plastics Pipe and Fittings Materials~~
~~ASTM D3753~~	~~(2019) Glass-Fiber-Reinforced Polyester Manholes and Wetwells~~
~~ASTM D3840~~	~~(2014) "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Fittings for Nonpressure Applications~~
~~ASTM D4101~~	~~(2017) Standard Classification System and Basis for Specification for Polypropylene Injection and Extrusion Materials~~
~~ASTM D4161~~	~~(2014) "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Joints Using Flexible Elastomeric Seals~~
~~ASTM F477~~	~~(2014) Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe~~
~~ASTM F667/F667M~~	~~(2016) Standard Specification for 3 through 24 in. Corrugated Polyethylene Pipe and Fittings~~
~~ASTM F714~~	~~(2013; R 2019) Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter~~
~~ASTM F758~~	~~(2014) Smooth-Wall Poly(Vinyl Chloride) (PVC) Plastic Underdrain Systems for Highway, Airport, and Similar Drainage~~
~~ASTM F794~~	~~(2003; R 2014) Standard Specification for Poly(Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter~~
~~ASTM F894~~	~~(2019) Standard Specification for Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe~~
~~ASTM F949~~	~~(2020) Standard Specification for~~

	Poly(Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings
ASTM F1417	(2011a; E 2020) Standard Practice for Installation Acceptance of Plastic Non-pressure Sewer Lines Using Low-Pressure Air
ASTM F2736	(2013; E 2014) Standard Specification for 6 to 30 in. (152 To 762 mm) Polypropylene (PP) Corrugated Single Wall Pipe And Double Wall Pipe
ASTM F2764/F2764M	(2018a) Standard Specification for 6 to 60 in. [150 to 1500 mm] Polypropylene (PP) Corrugated Double and Triple Wall Pipe and Fittings for Non-Pressure Sanitary Sewer Applications

INTERNATIONAL ASSOCIATION OF PLUMBING AND MECHANICAL OFFICIALS (IAPMO)

IAPMO Z1000	(2013) Prefabricated Septic Tanks

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.27	(N0v 2016) Scaffolds and Roope Descent Systems

UNI-BELL PVC PIPE ASSOCIATION (UBPPA)

UBPPA UNI-B-6	(1998) Recommended Practice for Low-Pressure Air Testing of Installed Sewer Pipe

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for [Contractor Quality Control approval.] [information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Contractor's License; G[, [_____]]

SD-02 Shop Drawings

Installation Drawings; G[, [_____]]

SD-03 Product Data

Precast Concrete Manholes

Frames, Covers, and Gratings

Gravity Pipe

Pressure Pipe

Precast Concrete Septic Tanks; G[, [_____]]

SD-06 Test Reports

Precast Concrete Sewer Manhole Test; G[, [_____]]

Hydrostatic Sewer Test; G[, [_____]]

Infiltration Tests And Exfiltration Tests; G[, [_____]]

Negative Air Pressure Test; G[, [_____]]

Low-Pressure Air Tests; G[, [_____]]

Tests For Pressure Lines; G[, [_____]]

Deflection Testing

Concrete Pipe Test; G[, [_____]]

SD-07 Certificates

Portland Cement

Gaskets

Pre-Installation Inspection Request; G

Post-Installation Inspection; G

1.3 QUALITY CONTROL

1.3.1 Installer Qualifications

Install specified materials by a licensed underground utility Contractor licensed for such work in the state where the work is to be performed. Verify installing Contractor's License is current and state certified or state registered.

1.4 DELIVERY, STORAGE, AND HANDLING

1.4.1 Delivery and Storage

Check upon arrival; identify and segregate as to types, functions, and sizes. Store off the ground in a manner affording easy accessibility and not causing excessive rusting or coating with grease or other objectionable materials.

1.4.1.1 Piping

Inspect materials delivered to site for damage; store with minimum of handling. Store materials on site in enclosures or under protective coverings. Store plastic piping and jointing materials and rubber gaskets

under cover out of direct sunlight. Do not store materials directly on the ground. Keep inside of pipes and fittings free of dirt and debris.

[1.4.1.2 Cement, Aggregate, and Reinforcement

As specified in Section [03 30 00 CAST-IN-PLACE CONCRETE][03 30 53 MISCELLANEOUS CAST-IN-PLACE CONCRETE].

]1.4.2 Handling

Handle pipe, fittings, and other accessories in such manner as to ensure delivery to the trench in sound undamaged condition. [Take special care not to damage linings of pipe and fittings; if lining is damaged, make satisfactory repairs.] Carry, do not drag, pipe to trench. Store solvents, solvent compounds, lubricants, elastomeric gaskets, and any similar materials required to install the plastic pipe in accordance with the manufacturer's recommendation and discard those materials if the storage period exceeds the recommended shelf life. Discard solvents in use when the recommended pot life is exceeded.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

2.1.1 Sanitary Sewer Gravity Pipeline

[Provide [mains and laterals] [[_____] inch lines] of [clay pipe] [concrete pipe] [ductile-iron pipe] [polypropylene pipe] [or] [polyvinyl chloride (PVC) plastic pipe]. Provide building connections [[_____] inch lines] of [clay pipe] [concrete pipe] [or] [polyvinyl chloride (PVC) plastic pipe].] [Provide new and modify existing exterior sanitary gravity sewer piping and appurtenances. Provide each system complete and ready for operation. The exterior sanitary gravity sewer system includes equipment, materials, installation, and workmanship as specified herein more than 5 feet outside of building walls.]

2.1.2 Sanitary Sewer Pressure Lines

Provide pressure lines of [ductile iron pressure pipe] [concrete pressure pipe] [or] [polyvinyl chloride (PVC) plastic pressure pipe].

2.2 MATERIALS

Provide materials conforming to the respective specifications and other requirements specified below. Submit manufacturer's product specification,standard drawings or catalog cuts.

2.2.1 Gravity Pipe

2.2.1.1 Clay Piping

2.2.1.1.1 Clay Pipe and Fittings

ASTM C700, [standard strength] [extra strength] [bell-and-spigot piping only].

~~2.2.1.1.2 Clay Piping Jointing Materials~~

~~Use ASTM C425.~~

~~2.2.1.2 Concrete Gravity Sewer Piping~~

~~2.2.1.2.1 Concrete Gravity Pipe and Fittings~~

~~Provide [nonreinforced concrete pipe conforming to ASTM C14, Class [_____]][reinforced concrete pipe conforming to ASTM C76, Class [_____]]. Provide circular pipe with elliptical reinforcement having a readily visible line at least 12 inches long painted or otherwise applied on the inside and outside of the pipe at each end so that when the pipe is laid in the proper position, the line will be at the center of the top of the pipe. Provide fittings and specials conforming to the applicable requirements specified for the pipe including the strength of the pipe. [Use pipe and fittings containing [Type II] [Type V] [low alkali cement] cement conforming to ASTM C150/C150M.]~~

~~2.2.1.2.2 Jointing Materials for Concrete Gravity Piping~~

~~Provide gaskets and pipe ends for rubber gasket joint conforming to ASTM C443. Use gaskets suitable for use with sewage.~~

~~Submit certificates of compliance stating that the fittings or gaskets used for waste drains or lines designated on the plans as [_____] are [oil] [_____] resistant.~~

~~2.2.1.3 Ductile Iron Gravity Sewer Pipe and Associated Fittings~~

~~2.2.1.3.1 Ductile Iron Gravity Pipe and Fittings~~

~~Provide ductile iron pipe conforming to ASTM A746 with cement-mortar lining in conforming to AWWA C104/A21.4, Pressure Class [_____]. Provide push-on joints conforming to AWWA C111/A21.11.~~

~~2.2.1.4 PVC Gravity Sewer Piping~~

~~2.2.1.4.1 PVC Gravity Pipe and Fittings~~

~~[ASTM D3034, SDR 35, or ASTM F949 with ends suitable for elastomeric gasket joints.] [ASTM F794, Series 46, for ribbed sewer pipe with smooth interior, size 8 inch through 48 inch diameters.]~~

~~2.2.1.4.2 PVC Gravity Joints and Jointing Material~~

~~Provide joints conforming to ASTM D3212. Gaskets are to conform to ASTM F477.~~

~~2.2.2 Pressure Pipe~~

~~2.2.2.1 Concrete Pressure Piping~~

~~2.2.2.1.1 Concrete Pressure Pipe and Fittings~~

~~Provide pipe conforming to [AWWA C302 or to] ASTM C361. Design pipe for hydrostatic head of [100] [125] feet and external loading of [5] [10] [15] [20] feet of earth cover. Provide circular pipe with elliptical reinforcement having a readily visible line at least 12 inches long~~

painted or otherwise applied on the inside and outside of the pipe at each end so that when the pipe is laid in the proper position, the line will be at the center of the top of the pipe. [Use [Type II] [Type V] [low-alkali] cement conforming to AWWA C302 in manufacturing pipe and fittings] Provide fittings.

2.2.2.1.2 Jointing Materials for Concrete Pressure Piping

Provide gaskets as specified in [the referenced specification for the pipe] [ASTM C361] and are suitable for use with sewage.

2.2.2.2 Ductile Iron Pressure Piping

2.2.2.2.1 Ductile Iron Pressure Pipe and Fittings

Provide [push-on-joint] [mechanical joint] [flanged] ductile-iron pipe conforming to AWWA C151/A21.51, [Pressure Class [_____]] [Thickness Class [_____]]. Provide fittings conforming to AWWA C110/A21.10 or AWWA C153/A21.53. [Provide fittings with push-on joint ends conforming to AWWA C111/A21.11.] Use fittings which have a pressure rating at least equivalent to that of the pipe. Pipe and fittings are to have cement-mortar lining conforming to AWWA C104/A21.4, standard thickness.

2.2.2.2.2 Ductile Iron Pressure Joints and Jointing Materials

a. Joints, general: Use [push-on joints] [or] [mechanical joints]for pipe and fittings except as otherwise specified in this paragraph. [Use mechanical-joints where indicated.] [Use flanged joints where indicated.] [Joints made with sleeve-type mechanical coupling may be used in lieu of push-on joint.] [[Grooved] [or] [shouldered] type joints may be used in lieu of push-on joint [or flanged joint], except where joint is buried.]

b. Push-on joints: Shape of pipe ends and fitting ends, gaskets, and lubricant for joint assembly are to conform to AWWA C111/A21.11.

c. Mechanical joints: Dimensional and material requirements for pipe ends, glands, bolts and nuts, and gaskets are to conform to AWWA C111/A21.11.

d. Flanged joints: Provide bolts, nuts, and gaskets for flanged connections as recommended in the Appendix to AWWA C115/A21.15. Provide flange for setscrewed flanges of ductile iron, ASTM A536, Grade 65-45-12, and conforming to the applicable requirements of ASME B16.1, Class 250. Provide 190,000 psi tensile strength, heat treated, and zinc-coated steel setscrews for setscrewed flanges. Conform gasket for setscrewed flanges to the applicable requirements for mechanical-joint gaskets specified in AWWA C111/A21.11. Design of setscrewed gasket are to provide for confinement and compression of gasket when joint to adjoining flange is made.

e. Joints made with sleeve-type mechanical couplings: Provide couplings designed to couple plain-end piping by compression of a ring gasket at each end of the adjoining pipe sections. Provide couplings consisting of one middle ring flared or beveled at each end to provide a gasket seat, two follower rings, two resilient tapered rubber gaskets, and bolts and nuts to draw the follower rings toward each other to compress the gaskets. The middle ring and the follower rings are to be true circular sections free from irregularities, flat spots, and

surface defects; the design is to provide for confinement and compression of the gaskets. The middle ring is to be of cast-iron [or steel], and the follower rings are to be of malleable iron or ductile iron. Cast iron couplings are to conform to ASTM A48/A48M and not be less than Class 25. Malleable iron couplings are to conform to ASTM A47/A47M. Ductile iron couplings are to conform to ASTM A536. [Steel is to have a strength not less than that of the pipe.] Gaskets are to be designed for long life and resistance to set after installation and meet the applicable requirements specified for gaskets for mechanical joint in AWWA C111/A21.11. Bolts are to be track-head type; bolts and nuts are to be either of the following: bolts conforming to the tensile requirements of ASTM A307, Grade A, with nuts conforming to the tensile requirements of ASTM A563, Grade A; or round-head square-neck type bolts conforming to ASME B18.5.2.1M and ASME B18.5.2.2M with hex nuts conforming to ASME B18.2.2. Bolts are to be 5/8 inch in diameter; minimum number of bolts for each coupling are to be [_____] [for [_____] inch pipe [,[_____] for [_____] inch pipe,] and [_____] for [_____] inch pipe]. Bolt holes in follower rings are to be of a shape to hold fast the necks of the bolts used. Sleeve-type mechanical couplings are not to be used as an optional method of jointing except where pipeline is adequately anchored to resist tension pull across the joint.

f. [Grooved] [and] [Shouldered] Type Joints: [Grooved pipe ends] [Shouldered pipe ends] and couplings are to conform to AWWA C606. Joint dimensions are to be as specified in AWWA C606 for rigid joints.

2.2.2.3 PVC Pressure Pipe and Associated Fittings

Pipe, couplings and fittings are to be manufactured of materials conforming to ASTM D1784, Class 12454B.

2.2.2.3.1 Pipe and Fittings Less Than 4 inch Diameter

2.2.2.3.1.1 Screw-Joint

Provide pipe conforming to dimensional requirements of ASTM D1785, Schedule 80, with joints meeting requirements of 150 psi working pressure, 200 psi hydrostatic test pressure, unless otherwise shown or specified. Provide fittings for threaded pipe conforming to requirements of ASTM D2464, threaded to conform to the requirements of ASME B1.20.1 for use with Schedule 80 pipe and fittings. Pipe couplings when used, are to be tested as required by ASTM D2464.

2.2.2.3.1.2 Push-On Joint

ASTM D3139, with ASTM F477 gaskets.[Fittings for push-on joints are to be iron conforming to AWWA C110/A21.10 or AWWA C153/A21.53 and AWWA C111/A21.11 with a cement-mortar lining conforming to AWWA C104/A21.4, standard thickness.]

2.2.2.3.1.3 Solvent Cement Joint

Provide pipe conforming to dimensional requirements of ASTM D1785 or ASTM D2241 with joints meeting the requirements of 150 psi working pressure and 200 psi hydrostatic test pressure. Fittings for solvent cement jointing are to conform to ASTM D2466 or ASTM D2467.

~~2.2.2.3.2 Pipe and Fittings 4 inch Diameter And Larger~~

~~Provide pipe conforming to AWWA C900 and be plain end or gasket bell end, Pressure Class [150 (DR 18)] [ ], with cast-iron-pipe-equivalent OD. Fittings are to be gray-iron or ductile-iron conforming to AWWA C110/A21.10 or AWWA C153/A21.53 and AWWA C111/A21.11 with a cement-mortar lining conforming to AWWA C104/A21.4, standard thickness. Fittings for pipe to pipe push-on joint ends are to conform with AWWA C900.~~

~~2.2.2.4 High Density Polyethylene Pipe (HDPE)~~

~~ASTM F894, Class 63, size 18 inch through 120 inch. ASTM F714, size 4 inch through 48 inch, will have pipe stiffness greater than or equal to 1170/D for cohesionless material pipe trench backfills. For all PE pipes, the polyethylene are to be certified by the resin producer as meeting the requirements of ASTM D3350, cell Class 334433C or higher. Fittings for High Density Polyethylene Pipe are to meet the same material specifications as the pipe class. Joints for HDPE meetingASTM F894 will be rubber gasket joints conforming to ASTM F477. HDPE meeting ASTM F714 will have fused joints in accordance with manufacturer's instruction.~~

~~2.2.2.5 Reinforced Plastic Mortar Pipe (RPMP)~~

~~Reinforced plastic mortar pipe are to be produced be in accordance with ASTM D3262 and have an outside diameter equal to ductile iron pipe dimensions from 18 inch to 48 inch. The inner surface of the pipe is to have a smooth uniform continuous resin-rich surface liner. The minimum pipe stiffness is to be 36 psi. RPMP is to be in accordance with ASTM D3262. Fittings for RPMP: ASTM D3840. Joints for RPMP: Bell and spigot gasket coupling utilizing an elastomeric gasket in accordance with ASTM D4161 and ASTM F477.~~

~~2.2.2.6 Reinforced Thermosetting Resin Pipe (RTRP)~~

~~RTRP pipe: ASTM D3262. Fittings for RTRP: ASTM D3262. Joints for RTRP: Bell and spigot type utilizing an elastomeric gasket in accordance with ASTM F477.~~

~~2.2.2.6.1 Filament Wound RTRP-I~~

~~RTRP-I is to conform to ASTM D2996, except pipe is to have an outside diameter equal to cast iron outside diameter or standard weight steel pipe. The pipe is to be suitable for a normal working pressure of 150 psi at 73 degrees F. The inner surface of the pipe is to have a smooth uniform continuous resin-rich surface liner conforming to ASTM D2996.~~

~~2.2.2.6.2 Centrifugally Cast RTRP-II~~

~~RTRP-II is to conform to ASTM D2997. Pipe is to have an outside diameter equal to standard weight steel pipe.~~

~~2.2.2.7 Dual Wall and Triple Wall Polypropylene~~

~~12 to 30 inch polypropylene pipe having a smooth interior and annular exterior corrugations, in compliance with ASTM F2736. Provide 30 to 60 inch polypropylene pipe having a smooth interior and exterior surfaces with annular inner corrugations, in compliance with ASTM F2764/F2764M. Pipe is suitable for gravity flow only and is to have a minimum pipe stiffness of 46 psi when tested in accordance with ASTM D2412. Pipe sizes 12- through~~

~~60-inch diameters are to have a reinforced bell, manufacturer's pre-installed polymer composite band or a manufacturer's compatible pipe polymer composite band.~~

~~2.2.3 Piping Beneath Railroad Right-of-Way~~

~~Where pipeline passes under the right-of-way of a commercial railroad, piping is to conform to the specifications for pipelines conveying nonflammable substances in AREMA Eng Man, except as otherwise specified in this paragraph. For casing pipe provide ductile-iron pipe in lieu of cast-iron soil pipe. Ductile-iron pipe is to conform to and have strength computed in accordance with ASTM A746.~~

~~2.2.4 Cement Mortar~~

~~Provide cement mortar conforming to ASTM C270, Type M with Type II cement.~~

~~2.2.5 Portland Cement~~

~~Submit certificates of compliance stating the type of cement used in manufacture of concrete pipe, fittings, septic tanks, and precast manholes. Provide portland cement conforming to ASTM C150/C150M, Type [II] [V] for concrete used in concrete pipe, concrete pipe fittings, septic tanks, and manholes and type optional for cement used in concrete cradle, concrete encasement, and thrust blocking. [Use air-entraining admixture conforming to ASTM C260/C260M with Type V cement.] [,Use a cement containing less than 0.60 percent alkalies where aggregates are alkali reactive, as determined by Appendix XI of ASTM C33/C33M.]~~

~~2.2.6 Portland Cement Concrete~~

~~Provide portland cement concrete conforming to ASTM C94/C94M, compressive strength of 4000 psi at 28 days, except for concrete cradle and encasement or concrete blocks for manholes. Concrete used for cradle and encasement is to have a compressive strength of 2500 psi minimum at 28 days. Protect concrete in place from freezing and moisture loss for 7 days.~~

~~2.2.7 Precast Concrete Manholes~~

~~Provide precast concrete manholes, risers, base sections, and tops conforming to ASTM C478[and be manufactured in accordance with Section 03 42 13.00 10 PLANT-PRECAST CONCRETE PRODUCTS FOR BELOW GRADE CONSTRUCTION; base and first riser are to be monolithic].~~

~~2.2.8 Glass-Fiber-Reinforced Polyester Manholes~~

~~Glass-Fiber-Reinforced Polyester Manholes are to conform to ASTM D3753.~~

~~2.2.9 Gaskets and Connectors~~

~~Provide gaskets for joints between [manhole] [wastewater tanks]sections conforming to ASTM C443. Resilient connectors for making joints between [manhole] [wastewater tanks] and pipes entering manhole are to conform to[ASTM C1644] [ASTM C923 or ASTM C990].~~

~~2.2.10 External Preformed Rubber Joint Seals~~

~~An external preformed rubber joint seal is an accepted method of sealing cast iron covers to precast concrete sections to prevent ground water~~

infiltration into sewer systems. All finished and sealed manholes constructed in accordance with paragraph entitled "Manhole Construction" are to be tested for leakage in the same manner as pipelines as described in paragraph entitled "Leakage Tests." The seal is to be multi-section with a neoprene rubber top section and all lower sections made of Ethylene Propylene Diene Monomer (EPDM) rubber with a minimum thickness of 60 mils. Each unit is to consist of a top and bottom section and have mastic on the bottom of the bottom section and mastic on the top and bottom of the top section. The mastic is to be a non-hardening butyl rubber sealant and seal to the cone/top slab of the manhole/catch basin and over the lip of the casting. Extension sections are to cover up to two more adjusting rings. Properties and values are listed in the following table:

Properties, Test Methods and Minimum Values for Rubber used in Preformed Joint Seals				
Physical Properties	Test Methods	EPDM	Neoprene	Butyl Mastic
Tensile, psi	ASTM D412	1840	2195	--
Elongation, percent	ASTM D412	553	295	350
Tear Resistance, ppi	ASTM D624 (Die B)	280	160	--
Rebound, percent, 5 minutes	ASTM C972 (mod.)	--	--	11
Rebound, percent, 2 hours	ASTM C972	--	--	12

[2.2.11 Precast Concrete Septic Tanks

Provide precast concrete septic tanks risers, base sections, and tops conforming to ASTM C1227 and be manufactured in accordance with Section 03 42 13.00 10 PLANT-PRECAST CONCRETE PRODUCTS FOR BELOW GRADE CONSTRUCTION; base and first riser are to be monolithic.

][2.2.12 Glass-Fiber-Reinforced Polyester Septic Tanks

Glass-Fiber-Reinforced Polyester Septic Tanks are to conform to IAPMO Z1000.

]2.2.13 Septic Tank Piping

PVC pipe and fittings. [Provide NSF/ANSI 46 certified effluent filter on the outlet pipe.]

2.2.14 Siphon for Septic Tank

PVC or Polyethylene,of an approved standard design, and prompt and positive in action.

2.2.15 Sewage Absorption Field Materials

[Pipe is to be perforated corrugated polyethylene tubing conforming to ASTM F667/F667M.] [Pipe is to be perforated PVC pipe conforming to

ASTM F758.] [Chambers are to be high density polyethylene conforming to IAPMO PS 63]

2.2.16 Frames, Covers, and Gratings for Manholes

[Submit certification on the ability of frame and cover to carry the imposed live load.] Frame and cover are to be cast gray iron, ASTM A48/A48M, Class 35B, cast ductile iron, ASTM A536, Grade 65-45-12, or reinforced concrete, ASTM C478 ASTM C478M. Frames and covers are to be circular [with] [without] vent holes. Size are to be [as indicated on the plans] [for 24 inch opening]. Stamp or cast the words "Sanitary Sewer" into covers so that it is plainly visible.

2.2.17 Manhole Steps

[Zinc-coated steel] [as indicated] conforming to 29 CFR 1910.27 [with a plastic or rubber coating pressure-molded to the steel is to be used. Provide plastic coating conforming to ASTM D4101, copolymer polypropylene. Rubber is to conform to ASTM C443, except shore A durometer hardness is to be 70 plus or minus 5.] Aluminum steps or rungs will not be permitted. Steps are not required in manholes less than 4 feet deep.

2.2.18 Manhole Ladders

Provide a steel ladder where the depth of a manhole exceeds 12 feet. The ladder is not to be less than 16 inches in width, with 3/4 inch diameter rungs spaced 12 inches apart. The two stringers are to be a minimum 3/8 inch thick and 2 inches wide. Galvanize ladders and inserts after fabrication in conformance with ASTM A123/A123M.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 Installation Drawings

Submit Installation Drawings showing complete detail, both plan and side view details with proper layout and elevations.

3.2 INSTALLATION

Backfill after inspection by the Contracting Officer. Before, during, and after installation, protect plastic pipe and fittings from any environment that would result in damage or deterioration to the material. Keep a copy of the manufacturer's instructions available at the construction site at all times and follow these instructions unless directed otherwise by the Contracting Officer.

3.2.1 Connections to Existing Lines

Obtain approval from the Contracting Officer before making connection to existing line. Conduct work so that there is minimum interruption of service on existing line.

3.2.2 General Requirements for Installation of Pipelines

These general requirements apply except where specific exception is made in the following paragraphs entitled "Special Requirements."

~~3.2.2.1 Location~~

~~Terminate the work covered by this section at a point approximately 5 feet from the building[, unless otherwise indicated]. Install pressure sewer lines beneath water lines only, with the top of the sewer line being at least 2 feet below bottom of water line. When these separation distances can not be met, contact the Contracting Officer for direction.~~

~~3.2.2.1.1 Sanitary Piping Installation Parallel with Water Line~~

~~3.2.2.1.1.1 Normal Conditions~~

~~Install sanitary piping or manholes at least 10 feet horizontally from a water line whenever possible. Measure the distance from edge-to-edge.~~

~~3.2.2.1.1.2 Unusual Conditions~~

~~When local conditions prevent a horizontal separation of 10 feet, the sanitary piping or manhole may be laid closer to a water line provided that:~~

~~a. The top (crown) of the sanitary piping is to be at least 18 inches below the bottom (invert) of the water main.~~

~~b. Where this vertical separation cannot be obtained, construct the sanitary piping with AWWA-approved ductile iron water pipe pressure and conduct a hydrostatic sewer testwithout leakage prior to backfilling.~~

~~c. The sewer manhole is to be of watertight construction and tested in place.~~

~~3.2.2.1.2 Installation of Sanitary Piping Crossing a Water Line~~

~~3.2.2.1.2.1 Normal Conditions~~

~~Lay sanitary sewer piping by crossing under water lines to provide a separation of at least 18 inches between the top of the sanitary piping and the bottom of the water line whenever possible.~~

~~3.2.2.1.2.2 Unusual Conditions~~

~~When local conditions prevent a vertical separation described above, use the following construction:~~

~~a. Construct sanitary piping passing over or under water lines with AWWA-approved ductile iron water pressure piping and conduct a hydrostatic sewer testwithout leakage prior to backfilling.~~

~~b. Protect sanitary piping passing over water lines by providing:~~

~~(1) A vertical separation of at least 18 inches between the bottom of the sanitary piping and the top of the water line.~~

~~(2) Adequate structural support for the sanitary piping to prevent excessive deflection of the joints and the settling on and breaking of the water line.~~

(3) That the length, minimum 20 feet, of the sanitary piping be centered at the point of the crossing so that joints are equidistant and as far as possible from the water line.

3.2.2.1.3 Sanitary Sewer Manholes

No water piping shall pass through or come in contact with any part of a sanitary sewer manhole.

3.2.2.2 Earthwork

Perform earthwork operations in accordance with Section 31 00 00 EARTHWORK 31 23 00.00 20 EXCAVATION AND FILL.

3.2.2.3 Pipe Laying and Jointing

Inspect each pipe and fitting before and after installation; replace those found defective and remove from site. Provide proper facilities for lowering sections of pipe into trenches. Lay nonpressure pipe with the bell [or groove] ends in the upgrade direction. Adjust spigots in bells [and tongues in grooves] to give a uniform space all around. Blocking or wedging between bells and spigots [or tongues and grooves] will not be permitted. Replace by one of the proper dimensions, pipe or fittings that do not allow sufficient space for installation of joint material. At the end of each work day, close open ends of pipe temporarily with wood blocks or bulkheads. Provide batterboards not more than 25 feet apart in trenches for checking and ensuring that pipe invert elevations are as indicated. Laser beam method may be used in lieu of batterboards for the same purpose. Construct branch connections by use of regular fittings or solvent cemented saddles as approved. Provide saddles for PVC pipe conforming to Table 4 of ASTM D3034.

3.2.3 Special Requirements

3.2.3.1 Installation of Clay Piping

Install pipe and fittings in accordance with paragraph entitled "General Requirements for Installation of Pipelines" of this section and with the requirements of ASTM C12 for pipe laying. Make joints with a compression joint material specified for clay pipe joints and assemble in accordance with the recommendations of the manufacturer of the pipe.

3.2.3.2 Installation of Concrete Gravity Sewer Piping

Install pipe and fittings in accordance with paragraph entitled "General Requirements for Installation of Pipelines" of this section and with the provisions for rubber gasket jointing and jointing procedures of ACPA 01-103 or of ACPA 01-102, Chapter 9, "Installation, Inspection and Construction Testing." Make joints with the gaskets specified for concrete gravity sewer pipe joints. Clean and dry surfaces receiving lubricants, cements, or adhesives. Affix gaskets to pipe not more than 24 hours prior to the installation of the pipe. Protect gaskets from sun, blowing dust, and other deleterious agents at all times. Before installation of the pipe, inspect gaskets and remove and replace loose or improperly affixed gaskets. Align each pipe section with the previously installed pipe section, and pull the joint together. If, while pulling the joint, the gasket becomes loose and can be seen through the exterior joint recess when the pipe is pulled up to within 1 inch of closure, remove the pipe and remake the joint.

~~3.2.3.3 Installation of Concrete Pressure Lines~~

~~Unless otherwise specified, install pipe and fittings in accordance with paragraph entitled "General Requirements for Installation of Pipelines" of this section and with the laying and joining requirements specified in the guide specifications for installation of pipe given in AWWA M9, Chapter 14, "Guide Specifications for Installation of Pipe."~~

~~3.2.3.3.1 Joints~~

~~Make joints with the gaskets specified for concrete pressure pipe joints, using an approved lubricant recommended by the pipe manufacturer. Assemble these joints in accordance with the joining requirements specified in the guide specifications for installation of pipe given in AWWA M9, Chapter 14, "Guide Specifications for Installation of Pipe," and with the recommendations given for laying the pipe in AWWA M9, Chapter 6, "Installation by Trenching or Tunneling -- Methods and Equipment."~~

~~3.2.3.3.2 Pipe Anchorage~~

~~Provide concrete thrust blocks (reaction backing) for pipe anchorage. Size and position thrust blocks as indicated. Use concrete conforming to ASTM C94/C94M having a minimum compressive strength of 2,000 psi at 28 days; or use concrete of a mix not leaner than one part cement 2 1/2 parts sand, and 5 parts gravel, having the same minimum compressive strength.~~

~~3.2.3.4 Installation of Ductile Iron Gravity Sewer Pipe~~

~~Unless otherwise specified, install pipe and associated fittings in accordance with paragraph entitled "General Requirements for Installation of Pipelines" of this section and with the requirements of AWWA C600 for pipe installation and joint assembly.~~

~~a. [Make push-on joints with the gaskets and lubricant specified for this type joint and assemble in accordance with the applicable requirements of AWWA C600 for joint assembly.] Make mechanical-joints with the gaskets, glands, bolts, and nuts specified for this type joint and assemble in accordance with the applicable requirements of AWWA C600 for joint assembly and the recommendations of Appendix A to AWWA C111/A21.11.~~

~~b. Exterior protection: Completely encase buried ductile iron pipelines with polyethylene tube or sheet in accordance with AWWA C105/A21.5, using [Class A] [Class C] polyethylene film.~~

~~3.2.3.5 Installation of Ductile-Iron Pressure Lines~~

~~Unless otherwise specified, install pipe and fittings in accordance with paragraph entitled "General Requirements for Installation of Pipelines" of this section and with the requirements of AWWA C600 for pipe installation, joint assembly, and valve-and-fitting installation.~~

~~a. [Make push-on joints with the gaskets and lubricant specified for this type joint and assemble in accordance with the applicable requirements of AWWA C600 for joint assembly.] Make mechanical-joints with the gaskets, glands, bolts, and nuts specified for this type joint; assemble in accordance with the applicable requirements of AWWA C600 for joint assembly and the recommendations of Appendix A to~~

AWWA C111/A21.11. [Make flanged joints with gaskets, bolts, and nuts specified for this type joint. Make flanged joints up tight, taking care to avoid undue strain on flanges, fittings, and other accessories. Align bolt holes for each flanged joint. Use full size bolts for the bolt holes; use of undersized bolts to make up for misalignment of bolt holes or for any other purpose will not be permitted. Do not allow adjoining flange faces to be out of parallel to such degree that the flanged joint cannot be made watertight without overstraining the flange. When flanged pipe or fittings have dimensions that do not allow the making of a proper flanged joint as specified, replace it by one of proper dimensions.] [Assemble joints made with sleeve-type mechanical couplings in accordance with the recommendations of the coupling manufacturer, as approved.] [Make [grooved] [and] [shouldered] type joints with the couplings previously specified for this type joint connecting pipe with the [grooved] [or] [shouldered] ends specified for this type joint and assemble in accordance with the recommendations of the coupling manufacturer, as approved. [Groove pipe in the field only with approved groove cutting equipment designed especially for the purpose and produced by a manufacturer of grooved joint couplings; secure approval for field-cut grooves before assembling the joint.]]

b. Exterior protection: Completely encase buried ductile iron pipelines with polyethylene tube or sheet in accordance with AWWA C105/A21.5, using [Class A] [Class C] polyethylene film.

c. Pipe anchorage: Provide concrete thrust blocks (reaction backing) for pipe anchorage. Size and position thrust blocks as indicated. Use concrete conforming to ASTM C94/C94M having a minimum compressive strength of 2,000 psi at 28 days; or use concrete of a mix not leaner than one part cement, 2 1/2 parts sand, and 5 parts gravel, having the same minimum compressive strength.

3.2.3.6 Installation of PVC Piping

Install pipe and fittings in accordance with paragraph entitled "General Requirements for Installation of Pipelines" of this section and with the requirements of ASTM D2321 for laying and joining pipe and fittings. Make joints with the gaskets specified for joints with this piping and assemble in accordance with the requirements of ASTM D2321 for assembly of joints. Make joints to other pipe materials in accordance with the recommendations of the plastic pipe manufacturer.

3.2.3.7 Installation of PVC Pressure Pipe

Unless otherwise specified, install pipe and fittings in accordance with AWWA C605. AWWA C605 includes requirements such as excavation, installation, and placement of apputenances.

3.2.3.7.1 Pipe Less Than 4 Inch Diameter

3.2.3.7.1.1 Threaded Joints

Make by wrapping the male threads with joint tape or by applying an approved thread lubricant, then threading the joining members together. Tighten the joints with strap wrenches which will not damage the pipe and fittings. Tighten the joint no more than 2 threads past hand-tight.

~~3.2.3.7.1.2 Push-On Joints~~

~~Bevel the ends of pipe for push-on joints to facilitate assembly. Mark pipe to indicate when the pipe is fully seated. Lubricate the gasket to prevent displacement. Exercise care to ensure that the gasket remains in proper position in the bell or coupling while making the joint.~~

~~3.2.3.7.1.3 Solvent-Weld Joints~~

~~Comply with the manufacturer's instructions.~~

~~3.2.3.7.2 Pipe 4 inch Diameter And Larger~~

~~Make push-on joints with AWWA C900 pipe with intrgral elastomeric gasket . For pipe-to-pipe push-on joint connections, use only pipe with push-on joint ends having factory-made bevel. For push-on joint connections to fittings, use cut spigot end of pipe off square, marked to match the manufacturer's insertion line and beveled to match factory supplied bevel. . Use an approved lubricant recommended by the pipe manufacturer for push-on joints. Assemble push-on joints for pipe-to-pipe joint connections in accordance with the requirements of AWWA C605. Assemble push-on joints for connection to fittings in accordance with the requirements of AWWA C605 for joining PVC pipe to fittings and accessories and with the applicable requirements of AWWA C600 for joint assembly. Make mechanical-joints or flanged jointswith the gaskets, glands, bolts, nuts, and internal stiffeners specified for this type joint and assemble in accordance with the requirements of AWWA C605 for joining PVC pipe to fittings and accessories or with the applicable requirements of AWWA C600 for ductile iron joint assembly, and with the recommendations of Appendix A to AWWA C111/A21.11. Cut off spigot end of pipe for mechanical-joint or flanged jointconnections and do not bevel.~~

~~3.2.3.7.3 Pipe Anchorage~~

~~Provide concrete thrust blocks (reaction backing) for pipe anchorage. Size and position thrust blocks as indicated. Use concrete conforming to ASTM C94/C94M having a minimum compressive strength of 2,000 psi at 28 days; or use concrete of a mix not leaner than one part cement, 2 1/2 parts sand, and 5 parts gravel, having the same minimum compressive strength.~~

~~3.2.3.8 Installation of Dual Wall and Triple Wall Polypropylene~~

~~Install pipe in accordance with "General Requirements for installation of Pipelines" of this section, with the polypropylene pipe manufacturer's recommendations, and with the requirements of ASTM D2321 for laying and joining pipe and fittings. Place a minimum of 6 inches of Class 1 or Class 2 backfill over the crown of the pipe with minimum 90 percent compaction.~~

~~3.2.3.9 Pipeline Installation Beneath Railroad Right-of-Way~~

~~Where pipeline passes under the right-of-way of a commercial railroad, install piping in accordance with the specifications for pipelines conveying nonflammable substances in AREMA Eng Man.~~

~~3.2.4 Concrete Work~~

~~Cast-in-place concrete is included in Section [03 30 00 CAST-IN-PLACE~~

~~CONCRETE][03 30 53 MISCELLANEOUS CAST-IN-PLACE CONCRETE]. Support the pipe on a concrete cradle, or encased in concrete where indicated or directed.~~

~~3.2.5 Manhole Construction~~

~~Construct base slab of cast-in-place concrete or use precast concrete base sections. Make inverts in cast-in-place concrete and precast concrete bases with a smooth-surfaced semi-circular bottom conforming to the inside contour of the adjacent sewer sections. For changes in direction of the sewer and entering branches into the manhole, make a circular curve in the manhole invert of as large a radius as manhole size will permit. For cast-in-place concrete construction, either pour bottom slabs and walls integrally or key and bond walls to bottom slab. No parging will be permitted on interior manhole walls. For precast concrete construction, make joints between manhole sections with the gaskets specified for this purpose; install in the manner specified for installing joints in concrete piping. Parging will not be required for precast concrete manholes. Perform cast-in-place concrete work in accordance with the requirements specified under paragraph entitled "Concrete Work" of this section. Make joints between concrete manholes and pipes entering manholes with the resilient connectors specified for this purpose; install in accordance with the recommendations of the connector manufacturer. Where a new manhole is constructed on an existing line, remove existing pipe as necessary to construct the manhole. Cut existing pipe so that pipe ends are approximately flush with the interior face of manhole wall, but not protruding into the manhole. Use resilient connectors as previously specified for pipe connectors to concrete manholes.~~

~~3.2.6 Miscellaneous Construction and Installation~~

~~3.2.6.1 Connecting to Existing Manholes~~

~~Connect pipe to existing manholes such that finish work will conform as nearly as practicable to the applicable requirements specified for new manholes, including all necessary concrete work, cutting, and shaping. Center the connection on the manhole. Holes for the new pipe are be of sufficient diameter to allow packing cement mortar around the entire periphery of the pipe but no larger than 1.5 times the diameter of the pipe. Cut the manhole in a manner that will cause the least damage to the walls.~~

~~3.2.6.2 Metal Work~~

~~3.2.6.2.1 Workmanship and Finish~~

~~Perform metal work so that workmanship and finish will be equal to the best practice in modern structural shops and foundries. Form iron to shape and size with sharp lines and angles. Do shearing and punching so that clean true lines and surfaces are produced. Make castings sound and free from warp, cold shuts, and blow holes that may impair their strength or appearance. Give exposed surfaces a smooth finish with sharp well-defined lines and arises. Provide necessary rabbets, lugs, and brackets wherever necessary for fitting and support.~~

~~3.2.6.2.2 Field Painting~~

~~After installation, clean cast-iron frames, covers, gratings, and steps not buried in concrete to bare metal, remove mortar, rust, grease, dirt,~~

and other deleterious materials and apply a coat of bituminous paint. Do not paint surfaces subject to abrasion.

3.2.7 Sewage Absorption Trench Construction

Grade trenches uniformly with no slope. [Lay perforated pipe with the perforations downward.] [Comply with the chamber manufacturer's instructions.]

3.2.8 Installations of Wye Branches

Install wye branches in an existing sewer using a method which does not damage the integrity of the existing sewer. Do not cutinto piping for connections except when approved by the Contracting Officer. When the connecting pipe cannot be adequately supported on undisturbed earth or tamped backfill, support on a concrete cradle as directed by the Contracting Officer. Provide and install concrete required because of conditions resulting from faulty construction methods or negligence without any additional cost to the Government. Do not damage the existing sewer when installing wye branches in an existing sewer.

3.3 FIELD QUALITY CONTROL

The Contracting Officer will conduct field inspections and witness field tests specified in this section. Be able to produce evidence, when required, that each item of work has been constructed in accordance with the drawings and specifications.

[3.3.1 Tests

Perform field tests and provide labor, equipment, and incidentals required for testing[, except that water and electric power needed for field tests will be furnished as set forth in Section [_____]].

3.3.1.1 Hydrostatic Sewer Test

When unusual conflicts are encountered between sanitary sewer and waterlines a hydrostatic pressure sewer test will be performed in accordance with the applicable AWWA standard for the piping material or AWWA C600[with a minimum test pressure of [_____]].

3.3.1.2 Leakage Tests for Nonpressure Lines

Test lines for leakage by either [infiltration tests and exfiltration tests,] [negative air pressure tests] [or by low-pressure air tests]. When necessary to prevent pipeline movement during testing, place additional backfill around pipe sufficient to prevent movement, but leaving joints uncovered to permit inspection. When leakage or pressure drop exceeds the allowable amount specified, make satisfactory correction and retest pipeline section in the same manner. Correct visible leaks regardless of leakage test results.

3.3.1.2.1 Infiltration Tests and Exfiltration Tests

[3.3.1.2.1.1 Precast Concrete Pipe Sewer Lines

Test leakage of precast concrete pipe in accordance with ASTM C969. The allowable leakage limit is located in ASTM C969. Make calculations in accordance with the Appendix to ASTM C969.

~~][3.3.1.2.2 Negative Air Pressure Test~~

~~[3.3.1.2.2.1 Concrete Pipe~~

~~Test concrete pipe test in accordance with ASTM C1214. The allowable vacuum loss is located in ASTM C1214 Make calculations in accordance with the Appendix to ASTM C1214.~~

~~][3.3.1.2.2.2 Precast Concrete Manholes~~

~~Test precast concrete sewer manhole test in accordance with ASTM C1244. The allowable vacuum drop is located in ASTM C1244 Make calculations in accordance with the Appendix to ASTM C1244.~~

~~]]3.3.1.2.3 Low-Pressure Air Tests~~

~~3.3.1.2.3.1 Clay Pipelines~~

~~Test clay pipe in accordance with ASTM C828. The allowable pressure drop is located in ASTM C828. Make calculations in accordance with the Appendix to ASTM C828.~~

~~3.3.1.2.3.2 PVC Pipelines~~

~~Test PVC pipe in accordance with UBPPA UNI-B-6. The allowable pressure drop is located in UBPPA UNI-B-6. Make calculations in accordance with the Appendix to UBPPA UNI-B-6.~~

~~3.3.1.2.3.3 Dual Wall and Triple Wall Polypropylene~~

~~Test polypropylene pipe in accordance with ASTM F1417 or UBPPA UNI-B-6. The allowable pressure drop is located in ASTM F1417 or UBPPA UNI-B-6 depending on the chosen test procedure. Make calculations in accordance with the Appendix to ASTM F1417 or UBPPA UNI-B-6 depending on the chosen test procedure.~~

~~[3.3.1.3 Tests for Pressure Lines~~

~~Test pressure lines in accordance with the applicable standard specified in this paragraph[, except for test pressures. For hydrostatic pressure test, use a hydrostatic pressure 50 psi in excess of the maximum working pressure of the system, but not less than 100 psi, holding the pressure for a period of not less than one hour. For leakage test, use a hydrostatic pressure not less than the maximum working pressure of the system]. Leakage test may be performed at the same time and at the same test pressure as the pressure test.~~

~~[3.3.1.3.1 Ductile-Iron Pressure Pipe~~

~~Test ductile-iron pressure pipe in accordance with the requirements of AWWA C600 for hydrostatic testing. Leakage on ductile-iron pipelines with mechanical-joints [or push-on joints] are not to exceed the amounts given in AWWA C600[; no leakage will be allowed at joints made by any other methods].~~

~~][3.3.1.3.2 Concrete Pressure Pipe~~

~~Test concrete pressure pipes in accordance with the recommendations in~~

~~AWWA M9. The leakage rate is dependent upon the type of concrete pressure used and the diameter of the pipe. The allowable leakage rate is indicated in AWWA M9, chapter titled, "Hydrostatic Testing and Disinfection of Mains".~~

~~][3.3.1.3.3 PVC Pressure Pipe~~

~~Test PVC pressure pipe in accordance with the requirements of AWWA C605 for hydrostatic and leakage tests. The quantity of water that must be supplied during testing is not to exceed the quantity of water calculated in accordance with AWWA C605 to maintain the specified test pressure within 5 psi.~~

~~]]3.3.1.4 Deflection Testing~~

~~Perform a deflection test on entire length of installed plastic pipeline on completion of work adjacent to and over the pipeline, including leakage tests, backfilling, placement of fill, grading, paving, concreting, and any other superimposed loads determined in accordance with ASTM D2412. Deflection of pipe in the installed pipeline under external loads is not to exceed 4.5 percent of the average inside diameter of pipe. Determine whether the allowable deflection has been exceeded by use of a pull-through device or a deflection measuring device.~~

~~3.3.1.4.1 Pull-Through Device~~

~~This device is to be a spherical, spheroidal, or elliptical ball, a cylinder, or circular sections fused to a common shaft. Space circular sections on the shaft so that the distance from external faces of front and back sections will equal or exceed the diameter of the circular section. Pull-through device may also be of a design promulgated by the Uni-Bell Plastic Pipe Association, provided the device meets the applicable requirements specified in this paragraph, including those for diameter of the device, and that the mandrel has a minimum of 9 arms. Ball, cylinder, or circular sections are to conform to the following:~~

~~a. A diameter, or minor diameter as applicable, of 95 percent of the average inside diameter of the pipe; tolerance of plus 0.5 percent will be permitted.~~

~~b. Homogeneous material throughout, is to have a density greater than 1.0 as related to water at 39.2 degrees F, and a surface Brinell hardness of not less than 150.~~

~~c. Center bored and through-bolted with a 1/4 inch minimum diameter steel shaft having a yield strength of not less than 70,000 psi, with eyes or loops at each end for attaching pulling cables.~~

~~d. Suitably Back each eye or loop with a flange or heavy washer such that a pull exerted on opposite end of shaft will produce compression throughout remote end.~~

~~3.3.1.4.2 Deflection Measuring Device~~

~~Sensitive to 1.0 percent of the diameter of the pipe being tested and be accurate to 1.0 percent of the indicated dimension. Prior approval is required for the deflection measuring device.~~

~~3.3.1.4.3 Pull-Through Device Procedure~~

~~Pass the pull-through device through each run of pipe, either by pulling it through or flushing it through with water. If the device fails to pass freely through a pipe run, replace pipe which has the excessive deflection and completely retest in same manner and under same conditions.~~

~~3.3.1.4.4 Deflection measuring device procedure~~

~~Measure deflections through each run of installed pipe. If deflection readings in excess of 4.5 percent of average inside diameter of pipe are obtained, retest pipe by a run from the opposite direction. If retest continues to show a deflection in excess of 4.5 percent of average inside diameter of pipe, replace pipe which has excessive deflection and completely retest in same manner and under same conditions.~~

~~[3.3.1.5 Dye Test~~

~~Perform a dye test from the projects sanitary sewer point of connection to the first downstream manhole on the next active sanitary sewer branch main. Use nontoxic non-staining sewer tracing dye. Test results are to be noted in the daily Construction Quality Control (CQC) Report as required in 01 45 00.00 10 Quality Control.~~

~~a. Continue testing until it can be visually confirmed by way of the dye that the sewer connection is appropriate or until deficiencies are discovered.~~

~~b. During the test, monitor the storm drainage system downstream from the project, either manholes or outfalls, for any sign of cross-connection.~~

~~][3.3.1.6 Smoke Test~~

~~Perform a smoke test on the relevant portion of the sewer system. Test results are to be noted in the daily Construction Quality Control (CQC) as required in 01 45 00.00 10 Quality Control.~~

~~a. Continue testing until it can be visually confirmed that the projects sanitary sewer point of connection has not been cross-connected to the storm drainage system.~~

~~b. During the test, monitor the storm drainage system, either manholes or outfalls, for any sign of cross-connection.~~

~~]][3.3.2 Field Tests for Cast-In-Place Concrete~~

~~Field testing requirements are covered in Section [03 30 00 CAST-IN-PLACE CONCRETE][03 30 53 MISCELLANEOUS CAST-IN-PLACE CONCRETE]~~

~~][3.3.3 Inspection~~

~~Check each straight run of pipeline for gross deficiencies by holding a light in a manhole; the light must show a practically full circle of light through the pipeline when viewed from the adjoining end of line.~~

~~3.3.3.1 Pre-Installation Inspection~~

~~Prior to connecting the new service, perform pre-installation inspection after trenching and layout is complete. Submit pre-installation~~

~~inspection request for field support at least [14] [_____] days in advance. The Installation's Utilities Field Support personnel will perform the pre-installation inspection.~~

~~3.3.3.2 Post-Installation Inspection~~

~~Perform a post-installation inspection after connection has been made and before the connection is buried. Submit post-installation inspection request for field support at least [14] [_____] days in advance. The Installation's Utilities Field Support personnel will perform the post-connection inspection.[During the post-installation inspection the Contractor will be responsible for performing a [dye test] [smoke test].]~~

~~] -- End of Section --~~PART 1 GENERAL

See attached American Water Military Services Specification after this section.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

-- End of Section --