

NRL BUILDING 250 - CLEAN ROOMS S7 & S8 TABLE OF CONTENTS

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SECTION 01110N

SUMMARY OF WORK

PART 1 GENERAL

1.1 WORK COVERED BY CONTRACT DOCUMENTS

1.1.1 Project Description

The work includes two (2) new Class 100 Clean Rooms approximately 22' x 25' with all associated HVAC and electrical service within an occupied building. the Contractor shall take all precautions to ensure the construction work dos not interfere with ongoing building functions.

1.1.2 Location

The work shall be located at the Naval Research Laboratory in Building 250, approximately as indicated. The exact location will be shown by the Contracting Officer.

1.2 EXISTING WORK

In addition to "FAR 52.236-9, Protection of Existing Vegetation, Structures, Equipment, Utilities, and Improvements":

- a. Remove or alter existing work in such a manner as to prevent injury or damage to any portions of the existing work which remain.
- b. Repair or replace portions of existing work which have been altered during construction operations to match existing or adjoining work, as approved by the Contracting Officer. At the completion of operations, existing work shall be in a condition equal to or better than that which existed before new work started.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

Not used.

-- End of Section --

SECTION 01140N

WORK RESTRICTIONS

PART 1 GENERAL

1.1 CONTRACTOR ACCESS AND USE OF PREMISES

1.1.1 Activity Regulations

Ensure that Contractor personnel employed on the Activity become familiar with and obey Activity regulations including safety, fire, traffic and security regulations. Keep within the limits of the work and avenues of ingress and egress. Wear hard hats in designated areas. Do not enter any restricted areas unless required to do so and until cleared for such entry.

The Contractor's equipment shall be conspicuously marked for identification. Contractor shall use work practices and equipment that will help to control noise levels. Also welding and cutting/burning fumes shall be exhausted to the exterior of the building (outside the building envelope) or controlled with appropriate pollution control devices.

1.1.2 Working Hours

Regular working hours shall consist of an 8 1/2 hour period, between 7 a.m. and 3:30 p.m., Monday through Friday, excluding Government holidays.

1.1.3 Work Outside Regular Hours

Work outside regular working hours requires Contracting Officer approval. Make application 15 calendar days prior to such work to allow arrangements to be made by the Government for inspecting the work in progress, giving the specific dates, hours, location, type of work to be performed, contract number and project title. Based on the justification provided, the Contracting Officer may approve work outside regular hours. During periods of darkness, the different parts of the work shall be lighted in a manner approved by the Contracting Officer.

1.1.4 Utility Cutovers and Interruptions

- a. Make utility cutovers and interruptions to occupiable spaces after normal working hours or on Saturdays, Sundays, and Government holidays unless otherwise allowed in writing by the Contracting Officer. Conform to procedures required in the paragraph "Work Outside Regular Hours."
- b. Ensure that utility work is complete, before interrupting existing service.
- c. Interruption to water, sanitary sewer, storm sewer, telephone service, electric service, fire alarm, and compressed air, shall be considered utility cutovers pursuant to the paragraph entitled "Work Outside Regular Hours."

1.2 SECURITY REQUIREMENTS

1.2 Naval Research Laboratory (NRL), Washington, DC

The Contractor shall be working in highly secured areas. All Contractor personnel must wear identification badges at all times. Restrict personnel to the designated project work site, as some areas of the base are restricted. No photographs shall be taken without approval from the Contracting Officer, and also in the presence of an approved Government Supervisor.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

Not used.

-- End of Section --

SECTION 01200N

PRICE AND PAYMENT PROCEDURES

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 in the text by the basic designation only.

U.S. ARMY CORPS OF ENGINEERS (USACE)

COE EP-1110-1-8 (1995) Construction Equipment Ownership
and Operating Expense Schedule

1.2 SUBMITTALS

Submit the following in accordance with Section 01330, "Submittal Procedures."

SD-01 Preconstruction Submittals

Schedule of prices; G

1.3 SCHEDULE OF PRICES

1.3.1 Data Required

Within 15 calendar days of notice of award, prepare and deliver to the Contracting Officer a schedule of prices (construction contract) on the forms furnished by the Government. Provide a detailed breakdown of the contract price, giving quantities for each of the various kinds of work, unit prices, and extended prices therefor.

1.3.2 Schedule Instructions

Payments will not be made until the Schedule of Prices has been submitted to and accepted by the Contracting Officer. Identify the cost for site work, and include incidental work to the 5 foot line. Identify costs for the building(s), and include work out to the 5 foot line. Work out to the 5 foot line shall include construction encompassed within a theoretical line 5 feet from the face of exterior walls and shall include attendant construction, such as cooling towers or the demolition of utility lines, placed beyond the 5 foot line.

1.4 CONTRACT MODIFICATIONS

In conjunction with the Contract Clause "DFARS 252.236-7000, Modification Proposals-Price Breakdown," and where actual ownership and operating costs of construction equipment cannot be determined from Contractor accounting

records, equipment use rates shall be based upon the applicable provisions of the COE EP-1110-1-8.

1.5 CONTRACTOR'S INVOICE AND CONTRACT PERFORMANCE STATEMENT

1.5.1 Content of Invoice

Requests for payment will be processed in accordance with the Contract Clause "FAR 52.232-27, Prompt Payment Construction Contracts."

- a. The Contractor's invoice certified by QC, on the form furnished by the Government for this purpose, showing in summary form, the basis for arriving at the amount of the invoice. Submit original and five copies.
- b. The Contract Performance Statement on the form furnished by the Government for this purpose, showing in detail, the estimated cost, percentage of completion, and value of completed performance. Submit original and two copies.
- c. Final invoice shall be accompanied by Final Release Form. If the contractor is incorporated, the release shall contain the corporate seal. An officer of the corporation shall sign the release and the corporate secretary shall certify the release
- d. Updated construction schedules (two copies).

1.5.2 Mailing of Invoices

- a. All invoices shall be forwarded with specific marking on the envelope. This marking shall be in the front lower left hand corner, in large letters, "INVOICES - ENCLOSED."
- b. Invoices not completed in accordance with contract requirements will be returned to the Contractor for correction of the deficiencies.
- c. Final invoices not accompanied by Final Release Form will be considered incomplete and will be returned to the Contractor.

1.6 PAYMENTS TO THE CONTRACTOR

Payments will be made on submission of itemized requests by the Contractor which comply with the requirements of this section, and will be subject to reduction for overpayments or increase for underpayments made on previous payments to the Contractor.

1.6.1 Obligation of Government Payments

The obligation of the Government to make payments required under the provisions of this contract will, at the discretion of the Contracting Officer, be subject to reductions and/or suspensions permitted under the FAR and agency regulations including the following in accordance with "FAR 32.503-6:

- a. Reasonable deductions due to defects in material or workmanship;
- b. Claims which the Government may have against the Contractor under or in connection with this contract;
- c. Unless otherwise adjusted, repayment to the Government upon demand for overpayments made to the Contractor; and
- d. Failure to provide up to date record drawings not current as stated in Contract Clause "FAC 5252.236-9310, Record Drawings."

1.6.2 Payment for Materials Offsite

Payments may be made to the Contractor for materials stored off construction sites under the following conditions:

- a. Conditions described in the paragraph entitled "Payments to the Contractor";
- b. Material within a distance of 50 miles by streets and roads to the construction site;
- c. Materials adequately insured and protected from theft and exposure;
- d. Materials not susceptible to deterioration or physical damage in storage or in transit to the job site are acceptable for progress payments. Items such as steel, machinery, pipe and fittings, and electrical cable are acceptable; items such as gypsum wallboard, glass, insulation, and wall coverings are not;
- e. Materials in transit to the job site or storage site are not acceptable for payment; and
- f. Conditions specified in "FAR 52.232-5(b) Payments Under Fixed Price Construction Contracts."

1.7 EQUITABLE ADJUSTMENTS: WAIVER AND RELEASE OF CLAIMS

- a. Except as the parties may otherwise expressly agree, the Contractor shall be deemed to have waived (1) any adjustments to which it otherwise might be entitled under the clause where such claim fails to request such adjustments, and (2) any increase in the amount of equitable adjustments additional to those requested in its claim.
- b. The Contractor agrees that, if required by the Contracting Officer, he will execute a release, in form and substance satisfactory to the Contracting Officer, as part of the supplemental agreement setting forth the aforesaid equitable adjustment. The Contractor further agrees that such release shall discharge the Government, its officers, agents and employees, from any further claims, including but not limited to, further claims arising out of delays or disruptions or both caused by the

aforesaid change.

PART 2 PRODUCTS

 Not used.

PART 3 EXECUTION

 Not used.

 -- End of Section --

SECTION 01310N

ADMINISTRATIVE REQUIREMENTS

PART 1 GENERAL

1.1 SUBMITTALS

Submit the following in accordance with Section 01330, "Submittal Procedures."

SD-01 Preconstruction Submittals

List of contact personnel; G

1.2 MINIMUM INSURANCE REQUIREMENTS

Procure and maintain during the entire period of performance under this contract the following minimum insurance coverage:

- a. Comprehensive general liability: \$500,000 per occurrence
- b. Automobile liability: \$200,000 per person, \$500,000 per occurrence for bodily injury, \$20,000 per occurrence for property damage.
- c. Workmen's compensation as required by Federal and State workers' compensation and occupational disease laws.
- d. Employer's liability coverage of \$100,000, except in States where workers compensation may not be written by private carriers,
- e. Others as required by State.

1.3 CONTRACTOR PERSONNEL REQUIREMENTS

1.3.1 Subcontractors and Personnel

Furnish a list of contact personnel of the Contractor and subcontractors including addresses and telephone numbers for use in the event of an emergency. As changes occur and additional information becomes available, correct and change the information contained in previous lists.

1.3.2 Identification Badges

Identification badges, will be furnished without charge. Application for and use of badges will be as directed. Each applicant must provide their social security number. Immediately report instances of lost or stolen badges to the Contracting Officer.

1.3.3 Subcontractor Special Requirements

1.3.3.1 Asbestos Containing Material

All contract requirements of Section 13281, "Engineering Control of Asbestos Containing Materials" assigned to the Private Qualified Person (PQP) shall be accomplished directly by a first tier subcontractor.

1.4 SUPERVISION

Have at least one qualified supervisor capable of reading, writing, and conversing fluently in the English language on the job site during working hours. In addition, if a Quality Control (QC) representative is required on the contract, then that individual shall also have fluent English communication skills.

1.5 PRECONSTRUCTION CONFERENCE

After award of the contract but prior to commencement of any work at the site, meet with the Contracting Officer to discuss and develop a mutual understanding relative to the administration of the value engineering and safety program, preparation of the schedule prices, shop drawings, and other submittals, scheduling programming, and prosecution of the work. Major subcontractors who will engage in the work shall also attend.

1.6 AVAILABILITY OF CADD DRAWING FILES

After award and upon request, the electronic "Computer-Aided Drafting and Design (CADD)" drawing files will be made available to the Contractor for us in preparation of construction data related to the referenced contract subject to the following terms and conditions:

- a. Data contained on these electronic files shall not be used for any purposes other than as a convenience in the preparation of construction 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 shall 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 shall, 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.
- b. These electronic CADD drawing files are not construction documents. Differences may exist between the CADD files and the corresponding construction documents. The Government makes no representation regarding the accuracy or completeness of the electronic CADD files, nor does it make representation to the compatibility of these files with the Contractors hardware or software. In the event that a conflict arises between the signed and sealed construction documents prepared by the Government and

the furnished CADD files, the signed and sealed construction documents shall govern. The Contractor is responsible for determining if any conflict exists. Use of these CADD 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.

- c. If the Contractor uses, duplicates or modified these electronic CADD files for use in producing construction data related to this contract, all previous indication of ownership (seals, logos, signatures, initials and dates) shall be removed.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

Not used.

-- End of Section --

SECTION 01330

SUBMITTAL PROCEDURES

PART 1 GENERAL

1.1 SUMMARY

1.1.1 Government-Furnished Information

Submittal register [database and submittal management program] will be delivered to the contractor, by contracting officer [on 3 1/2 inch disk]. Register[database] will have 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 No. and type, e.g. SD-04 Drawings) required in each specification section.

Column (e): Lists one principal paragraph in 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 project requirements.

Column (f): Indicate approving authority for each submittal. A "G" indicates approval by contracting officer; a blank indicates approval by QC manager.

[The database and submittal management program will be extractable from the disk furnished to contractor, for operation on contractor's IBM compatible personal computer with 640kb RAM, a hard drive, and 3 1/2 inch high density floppy disk drive.]

1.2 DEFINITIONS

1.2.1 Submittal

Shop drawings, product data, samples, operation and maintenance data, and administrative submittals presented for review and approval. Contract Clauses "FAR 52.236-5, Material and Workmanship," paragraph (b) and "FAR 52.236-21, Specifications and Drawings for Construction," paragraphs (d), (e), and (f) apply to all "submittals."

1.2.2 Types of Submittals

All submittals are classified as indicated in paragraph "Submittal Descriptions (SD)". Submittals also are grouped as follows:

- a. Shop drawings: As used in this section, drawings, schedules,

diagrams, and other data prepared specifically for this contract, by contractor or through contractor by way of subcontractor, manufacturer, supplier, distributor, or other lower tier contractor, to illustrate portion of work.

- b. Product data: Preprinted material such as illustrations, standard schedules, performance charts, instructions, brochures, diagrams, manufacturer's descriptive literature, catalog data, and other data to illustrate portion of work, but not prepared exclusively for this contract.
- c. Samples: Physical examples of products, materials, equipment, assemblies, or workmanship that are physically identical to portion of work, illustrating portion of work or establishing standards for evaluating appearance of finished work or both.
- d. Operation and Maintenance (O&M) Data:
Data that is furnished by the manufacturer, or the system provider, to the equipment operating and maintenance personnel. This data is needed by operating and maintenance personnel for the safe and efficient operation, maintenance and repair of the item. The data is required when the item is delivered to the project site.
- e. Administrative submittals: Data presented for reviews and approval to ensure that administrative requirements of project are adequately met but not to ensure directly that work is in accordance with design concept and in compliance with contract documents.

1.3 SUBMITTAL IDENTIFICATION (SD)

Submittals required are identified by SD numbers and titles as follows:

SD-01 Preconstruction Submittals

Certificates of insurance.
Surety bonds.
List of proposed subcontractors.
List of proposed products.
Construction Progress Schedule.
Submittal register.
Schedule of values.
Health and safety plan.
Work plan.
Quality control 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 or equipment for some portion of the work.

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

SD-04 Samples

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 by which the ensuring work can be judged. Includes assemblies or portions of assemblies which are to be incorporated into the project and those which will be removed at conclusion of the work.

SD-05 Design Data

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

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. (Testing must have been within three years of date of contract award for the project.)

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

Report which 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 checklists

Final acceptance test and operational test procedure

SD-07 Certificates

Statements signed by responsible officials of manufacturer of product, system or material attesting that 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 supplier, installer or subcontractor through Contractor, the purpose of which is to further quality of orderly progression of a portion of the work by documenting procedures, acceptability of methods or personnel qualifications.

Confined space entry permits.

SD-08 Manufacturer's Instructions

Preprinted material describing installation of a product, system or material, including special notices and Material Safety Data sheets concerning impedances, hazards and safety precautions.

SD-09 Manufacturer's Field Reports

Documentation of the testing and verification actions taken by manufacturer's representative to confirm compliance with manufacturer's standards or instructions.

Factory test reports.

SD-10 Operation and Maintenance Data

Data that is furnished by the manufacturer, or the system provider, to the equipment operating and maintenance personnel. This data is needed by operating and maintenance personnel for the safe and efficient operation, maintenance and repair of the item.

SD-11 Closeout Submittals

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

1.3.1 Approving Authority

Person authorized to approve submittal.

1.3.2 Work

As used in this section, on- 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.

1.4 SUBMITTALS

Submit the following in accordance with the requirements of this section.

SD-01 Preconstruction Submittals

Submittal register; G

1.5 USE OF SUBMITTAL REGISTER [DATABASE]

Prepare and maintain submittal register, as the work progresses.[Use electronic submittal register program furnished by the Government or any other format.] Do not change data which is output in columns (c), (d), (e), and (f) as delivered by government; retain data which is output in columns (a), (g), (h), and (i) as approved.

1.5.1 Submittal Register

Submit submittal register[as an electronic database, using submittals management program furnished to contractor]. Submit with quality control plan and project schedule required by Section 01450N, "Quality Control" and [Section 01321N, "Network Analysis Schedules."] [Section 01320N, "Construction Progress Documentation."] Do not change data in columns (c), (d), (e), and (f) as delivered by the government. Verify that all submittals required for project are listed and add missing submittals. Complete the following on the register[database]:

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

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

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

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

1.5.2 Contractor Use of Submittal Register

Update the following fields[in the government-furnished submittal register program or equivalent fields in program utilized by contractor].

Column (b) Transmittal Number: Contractor assigned list of consecutive numbers.

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

Column (l) List date of submittal transmission.

Column (q) List date approval received.

1.5.3 Approving Authority Use of Submittal Register

Update the following fields[in the government-furnished submittal register program or equivalent fields in program utilized by contractor].

Column (b).

Column (l) List date of submittal receipt.

Column (m) through (p).

Column (q) List date returned to contractor.

1.5.4 Contractor Action Code and Action Code

Entries used will be as follows (others may be prescribed by Transmittal Form):

NR - Not Received

AN - Approved as noted

A - Approved

RR - Disapproved, Revise, and Resubmit

1.5.5 Copies Delivered to the Government

Deliver one copy of submitted register updated by contractor to government with each invoice request. [Deliver in electronic format, unless a paper copy is requested by contracting officer.]

1.6 PROCEDURES FOR SUBMITTALS

1.6.1 Reviewing, Certifying, Approving Authority

QC organization shall be responsible for reviewing and certifying that submittals are in compliance with contract requirements. Approving authority on submittals is QC manager unless otherwise specified for specific submittal. At each "Submittal" paragraph in individual specification sections, a notation "G," following a submittal item, indicates contracting officer is approving authority for that submittal item.

1.6.2 Constraints

- a. Submittals listed or specified in this contract shall conform to provisions of this section, unless explicitly stated otherwise.
- b. Submittals shall be complete for each definable feature of work; components of definable feature interrelated as a system shall be submitted at same time.

- c. When acceptability of a submittal is dependent on conditions, items, or materials included in separate subsequent submittals, submittal will be returned without review.
- d. Approval of a separate material, product, or component does not imply approval of assembly in which item functions.

1.6.3 Scheduling

- a. Coordinate scheduling, sequencing, preparing and processing of submittals with performance of work so that work will not be delayed by submittal processing. Allow for potential requirements to resubmit.
- b. Except as specified otherwise, allow review period, beginning with receipt by approving authority, that includes at least [15] [_____] working days for submittals for QC Manager approval and [20] [_____] working days for submittals for contracting officer approval. Period of review for submittals with contracting officer approval begins when Government receives submittal from QC organization. Period of review for each resubmittal is the same as for initial submittal.
- c. For submittals requiring review by fire protection engineer, allow review period, beginning when government receives submittal from QC organization, of [30] [_____] working days for return of submittal to the contractor. Period of review for each resubmittal is the same as for initial submittal.

1.6.4 Variations

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

1.6.4.1 Considering Variations

Discussion with contracting officer prior to submission, will help ensure functional and quality requirements are met and minimize rejections and resubmittals. When contemplating a variation which results in lower cost, consider submission of the variation as a Value Engineering Change Proposal (VECP).

1.6.4.2 Proposing Variations

When proposing variation, deliver 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. If lower cost is a benefit, also include an estimate of the cost saving. In addition to documentation required for variation, include the submittals required for the item. Clearly mark the proposed variation in all documentation.

1.6.4.3 Warranting That Variations Are Compatible

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

1.6.4.4 Review Schedule Is Modified

In addition to normal submittal review period, a period of [10] [_____] working days will be allowed for consideration by the Government of submittals with variations.

1.6.5 Contractor's Responsibilities

- a. Determine and verify field measurements, materials, field construction criteria; review each submittal; and check and coordinate each submittal with requirements of the work and contract documents.
- b. Transmit submittals to QC organization in accordance with schedule on approved Submittal Register, and to prevent delays in the work, delays to government, or delays to separate contractors.
- c. Advise contracting officer of variation, as required by paragraph entitled "Variations."
- d. Correct and resubmit submittal as directed by approving authority. When resubmitting disapproved transmittals or transmittals noted for resubmittal, the contractor shall provide copy of that previously submitted transmittal including all reviewer comments for use by approving authority. Direct specific attention in writing or on resubmitted submittal, to revisions not requested by approving authority on previous submissions.
- e. Furnish additional copies of submittal when requested by contracting officer, to a limit of 20 copies per submittal.
- f. Complete work which must be accomplished as basis of a submittal in time to allow submittal to occur as scheduled.
- g. Ensure no work has begun until submittals for that work have been returned as "approved," or "approved as noted", except to the extent that a portion of work must be accomplished as basis of submittal.

1.6.6 QC Organization Responsibilities

- a. Note date on which submittal was received from contractor on each submittal.
- b. Review each submittal; and check and coordinate each submittal with requirements of work and contract documents.
- c. Review submittals for conformance with project design concepts and compliance with contract documents.

- d. Act on submittals, determining appropriate action based on QC organization's review of submittal.
 - (1) When QC manager is approving authority, take appropriate action on submittal from the possible actions defined in paragraph entitled, "Actions Possible."
 - (2) When contracting officer is approving authority or when variation has been proposed, forward submittal to Government with certifying statement or return submittal marked "not reviewed" or "revise and resubmit" as appropriate. The QC organization's review of submittal determines appropriate action.
- e. Ensure that material is clearly legible.
- f. Stamp each sheet of each submittal with QC certifying statement or approving statement, except that data submitted in bound volume or on one sheet printed on two sides may be stamped on the front of the first sheet only.
 - (1) When approving authority is contracting officer, QC organization will certify submittals forwarded to contracting officer with the following certifying statement:

"I hereby certify that the (equipment) (material) (article) shown and marked in this submittal is that proposed to be incorporated with contract Number [____], is in compliance with the contract drawings and specification, can be installed in the allocated spaces, and is submitted for Government approval.

Certified by Submittal Reviewer _____, Date _____
(Signature when applicable)

Certified by QC Manager _____, Date _____"
(Signature)

(2) When approving authority is QC Manager, QC Manager will use the following approval statement when returning submittals to contractor as "Approved" or "Approved as Noted."

"I hereby certify that the (material) (equipment) (article) shown and marked in this submittal and proposed to be incorporated with contract Number [____], is in compliance with the contract drawings and specification, can be installed in the allocated spaces, and is _____ approved for use.

Certified by Submittal Reviewer _____, Date _____
(Signature when applicable)

Approved by QC Manager _____, Date _____"
(Signature)

- g. Sign certifying statement or approval statement. The person signing certifying statements shall be QC organization member

designated in the approved QC plan. The signatures shall be in original ink. Stamped signatures are not acceptable.

- h. Update submittal register [database]as submittal actions occur and maintain the submittal register at project site until final acceptance of all work by contracting officer.
- i. Retain a copy of approved submittals at project site, including contractor's copy of approved samples.

1.6.7 Government's Responsibilities

When approving authority is Contracting Officer, the Government will:

- a. Note date on which submittal was received from QC manager, on each submittal for which the contracting officer is approving authority.
- b. Review submittals for approval within 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 entitled "Actions Possible" and with markings appropriate for action indicated.

1.6.8 Actions Possible

Submittals will be returned with one of the following notations:

- a. Submittals marked "not reviewed" will indicate 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.
- b. Submittals marked "approved" "approved as submitted" authorize contractor to proceed with work covered.
- c. Submittals marked "approved as noted" or "approval except as noted; resubmission not required" authorize contractor to proceed with work as noted provided contractor takes no exception to the notations.
- d. Submittals marked "revise and resubmit" or "disapproved" indicate submittal is incomplete or does not comply with design concept or requirements of the contract documents and shall be resubmitted with appropriate changes. No work shall proceed for this item until resubmittal is approved.

1.7 FORMAT OF SUBMITTALS

1.7.1 Transmittal Form

Transmit each submittal, except sample installations and sample panels, to office of approving authority. Transmit submittals with transmittal form prescribed by Contracting Officer and standard for project. The transmittal form shall identify Contractor, indicate date of submittal, and include information prescribed by transmittal form and required in paragraph entitled "Identifying Submittals." Process transmittal forms to record actions regarding sample panels and sample installations.

1.7.2 Identifying Submittals

Identify submittals, except sample panel and sample installation, with the following information permanently adhered to or noted on each separate component of each submittal and noted on transmittal form. Mark each copy of each submittal identically, with the following:

- a. Project title and location.
- b. Construction contract number.
- c. Section number of the specification section by which submittal is required.
- d. Submittal description (SD) number of each component of submittal.
- e. When a resubmission, add alphabetic suffix on submittal description, for example, SD-10A, to indicate resubmission.
- f. Name, address, and telephone number of subcontractor, supplier, manufacturer and any other second tier contractor associated with submittal.
- g. Product identification and location in project.

1.7.3 Format for Shop Drawings

- a. Shop drawings shall not be less than 8 1/2 by 11 inches nor more than 30 by 42 inches.
- b. Present 8 1/2 by 11 inches sized shop drawings as part of the bound volume for submittals required by section. Present larger drawings in sets.
- c. Include on each drawing the drawing title, number, date, and revision numbers and dates, in addition to information required in paragraph entitled "Identifying Submittals."
- d. Dimension drawings, except diagrams and schematic drawings; prepare drawings demonstrating interface with other trades to scale. Shop drawing dimensions shall be the same unit of measure as indicated on the contract drawings. Identify materials and products for work shown.

1.7.4 Format of Product Data

- a. Present product data submittals for each section as a complete, bound volume. Include table of contents, listing page and catalog item numbers for product data.
- b. Indicate, by prominent notation, each product which is being submitted; indicate specification section number and paragraph number to which it pertains.
- c. Supplement product data with material prepared for project to satisfy submittal requirements for which product data does not exist. Identify this material as developed specifically for project.

1.7.5 Format of Samples

- a. Furnish samples in sizes below, unless otherwise specified or unless the manufacturer has prepackaged samples of approximately same size as specified:
 - (1) Sample of Equipment or Device: Full size.
 - (2) Sample of Materials Less Than 2 by 3 inches: Built up to 8 1/2 by 11 inches.
 - (3) 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.
 - (4) 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.
 - (5) Sample of Non-Solid Materials: Pint. Examples of non-solid materials are sand and paint.
 - (6) Color Selection Samples: 2 by 4 inches.
 - (7) Sample Panel: 4 by 4 feet.
 - (8) Sample Installation: 100 square feet.
- b. Samples Showing Range of Variation: Where variations are unavoidable due to nature of the materials, submit sets of samples of not less than three units showing extremes and middle of range.
- c. Reusable Samples: Incorporate returned samples into work only if so specified or indicated. Incorporated samples shall be in undamaged condition at time of use.
- d. Recording of Sample Installation: Note and preserve the notation of area constituting sample installation but remove notation at final clean up of project.

- e. When color, texture or pattern is specified by naming a particular manufacturer and style, include one sample of that manufacturer and style, for comparison.

1.7.6 Format of Operation and Maintenance (O&M) Data

- a. O&M Data format shall comply with the requirements specified in Section 01781, Operation and Maintenance Data"

1.7.7 Format of Administrative Submittals

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

1.8 QUANTITY OF SUBMITTALS

1.8.1 Number of Copies of Shop Drawings

- a. Submit [six] [_____] copies of submittals of shop drawings requiring review and approval only by QC organization and [seven] [_____] copies of shop drawings requiring review and approval by Contracting Officer. 1.8.2 Number of Copies of Product Data

Submit product data in compliance with quantity requirements specified for shop drawings.

1.8.3 Number of Samples

- a. Submit [two] [_____] samples, or [two] [_____] sets of samples showing range of variation, of each required item. One approved sample or set of samples will be retained by approving authority and one will be returned to contractor.
- b. Submit one sample panel. Include components listed in technical section or as directed.
- c. Submit one sample installation, where directed.
- d. Submit one sample of non-solid materials.

1.8.4 Number of Copies of Operation and Maintenance Data

Submit [Five][three][_____] copies of O&M Data to the Contracting Officer for review and approval

1.8.5 Number of Copies of Administrative Submittals

- a. Unless otherwise specified, submit administrative submittals compliance with quantity requirements specified for shop drawings.

1.9 FORWARDING SUBMITTALS

1.9.1 Submittals Required from the Contractor

As soon as practicable after award of contract, and before procurement of fabrication, forward to the [Commander, LANTNAVFACENGCOM, Code CI4A1, 1510 Gilbert Street, Norfolk, Virginia, 23511-2699] [Architect-Engineer: [____],] submittals required in the technical sections of this specification, including shop drawings, product data and samples. One copy of the transmittal form for all submittals shall be forwarded to the Resident Officer in Charge of Construction.

[The Architect-Engineer for this project] [LANTNAVFACENGCOM] will review and provide surveillance for the Contracting Officer to verify Contractor-approved submittals comply with the contract requirements.

[The Architect-Engineer for this project] [LANTNAVFACENGCOM] will review and approve for the Contracting Officer those submittals reserved for Contracting Officer approval to verify submittals comply with the contract requirements.

1.9.1.1 O&M Data

[The Architect-Engineer for this project] [LANTNAVFACENGCOM] will review and approve for the Contracting Officer O&M Data to verify the submittals comply with the contract requirements.; submit data specified for a given item within 30 calendar days after the item is delivered to the contract site.

- a. In the event the Contractor fails to deliver O&M Data within the time limits specified, the Contracting Officer may withhold from progress payments 50 percent of the price of the item with which such O&M Data are applicable.

[1.9.1.2 Submittals Reserved for LANTNAVFACENGCOM Approval

As an exception to the standard submittal procedure specified above, submit the following to the Commander, LANTNAVFACENGCOM, Code CI4A1, 1510 Gilbert Street, Norfolk, Virginia 23511-2699:

- [a. Section [____], "[____]": Pile driving records]
- [b. Section [____], "[____]": All fire protection system submittals]
- [c. Section [____], "[____]": All fire alarm system submittals]
- [d. Section 15901, "Space Temperature Control Systems": SD-06 field test report submittals]
- [e. Section 15910N, "Direct Digital Control Systems": SD-06 field test report submittals]
- [f. Section 15950N, "HVAC Testing/Adjusting/Balancing": All submittals]

[g. Section 15951N, "Testing Industrial Ventilation Systems": All submittals]

[h. Section 16272N, "Three-Phase Pad Mounted Transformers": All submittals]

[i. Section 16273N, "Single-Phase Pad Mounted Transformers": All submittals]

[j. Section 16301N, "Overhead Transmission and Distribution": Transformer submittals]

[k. Section 16360N, "Secondary Unit Substations": Transformer submittals]

[l. Section 16361N, "Primary Unit Substations": Transformer submittals]

][1.9.1.3 Overseas Shop Drawing Submittals

All submittals shall be sent via overnight express mail service. All costs associated with the overnight express mail service shall be borne by the construction contractor. Costs associated with the overnight express mail of submittals related to proposed submittal variances of resubmittals necessary as a result of noncompliant or incomplete contractor submittals shall be the responsibility of the contractor.

]1.10 SUBMITTAL CLASSIFICATION

Submittals are classified as follows:

1.10.1 Designer of Record Approved

Designer of Record approval is required for extensions of design, critical materials, any deviations from the solicitation, the accepted proposal, or the completed design, equipment whose compatibility with the entire system must be checked, and other items as designated by the Contracting Officer. Within the terms of the Contract Clause entitled "Specifications and Drawings for Construction", they are considered to be "shop drawings". The Contractor shall provide the Government the number of copies designated hereinafter of all Designer of Record approved submittals. The Government may review any or all Designer of Record approved submittals for conformance to the Solicitation and Accepted Proposal. The Government will review all submittals designated as deviating from the Solicitation or Accepted Proposal, as described below. Design submittals shall be in accordance with Section 01012 DESIGN AFTER AWARD. Generally, design submittals should be identified as SD-05 DESIGN DATA submittals.

1.10.2 Government Approved

Government approval is required for extensions of design, critical materials, deviations, equipment whose compatibility with the entire system must be checked, and other items as designated by the Contracting Officer. Government approval is required for any deviations from the Solicitation or

Accepted Proposal and other items as designated by the Contracting Officer.

Within the terms of the Contract Clause entitled "Specifications and Drawings for Construction," they are considered to be "shop drawings."

1.10.3 Government Reviewed Design or Extension of Design

The Government will review all (___%) and (__%) design submittals for conformance with the technical requirements of the solicitation. Section 01012 DESIGN AFTER AWARD covers the design submittal and review process in detail. Government review is required for extension of design construction submittals, used to define contract conformity, and for deviation from the completed design. Review will be only for conformance with the contract requirements. Included are only those construction submittals for which the Designer of Record design documents do not include enough detail to ascertain contract compliance. The Government may, but is not required, to review extensions of design such as structural steel or reinforcement shop drawings.

1.10.4 Information Only

All submittals not requiring Government approval will be for information only. All submittals not requiring Designer of Record or Government approval will be for information only. They are not considered to be "shop drawings" within the terms of the Contract Clause referred to above.

All submittals not requiring Government approval will be for information only. They are not considered to be "shop drawings" within the terms of the Contract Clause referred to above.

1.11 APPROVED SUBMITTALS

The Contracting Officer's approval of submittals shall not be construed as a complete check, but will indicate only that the general method of construction, materials, detailing and other information are satisfactory design, general method of construction, materials, detailing and other information appear to meet the Solicitation and Accepted Proposal. Approval will not relieve the Contractor of the responsibility for any error which may exist, as the Contractor under the Contractor Quality Control (CQC) requirements of this contract is responsible for [dimensions, the design of adequate connections and details, and the satisfactory construction of all work][design, dimensions, all design extensions, such as the design of adequate connections and details, etc., and the satisfactory construction of all work.] . After submittals have been approved 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.

1.12 DISAPPROVED SUBMITTALS

The Contractor shall make all corrections required by the Contracting Officer and promptly furnish a corrected submittal in the form and number of copies specified for the initial submittal. The Contractor shall make all corrections required by the Contracting Officer, obtain the Designer of Record's approval when applicable, and promptly furnish a corrected submittal in the form and number of copies specified for the initial

submittal. Any "information only" submittal found to contain errors or unapproved deviations from the Solicitation or Accepted Proposal shall be resubmitted as one requiring "approval" action, requiring both Designer of Record and Government approval. If the Contractor considers any correction indicated on the submittals to constitute a change to the contract, a notice in accordance with the Contract Clause "Changes" shall be given promptly to the Contracting Officer.

1.13 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 if all required Designer of Record or required Government approvals have not 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.

1.14 GENERAL

The Contractor shall make submittals as required by the specifications. The Contracting Officer may request submittals in addition to those specified when deemed necessary to adequately describe the work covered in the respective sections. Units of weights and measures used on all submittals shall be the same as those used in the contract drawings. Each submittal shall be complete and in sufficient detail to allow ready determination of compliance with contract requirements. Prior to submittal, all items shall be checked and approved by the Contractor's Quality Control (CQC) System Manager and the Designer of Record, if applicable, and each item shall be stamped, signed, and dated by the CQC System Manager indicating action taken. Proposed deviations from the contract requirements shall be clearly identified. Submittals shall include 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. Submittals requiring Government approval shall be scheduled and made prior to the acquisition of the material or equipment covered thereby. Samples remaining upon completion of the work shall be picked up and disposed of in accordance with manufacturer's Material Safety Data Sheets (MSDS) and in compliance with existing laws and regulations.

1.15 SUBMITTAL REGISTER

At the end of this section is a submittal [register] [list] 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. [The Contractor shall maintain a submittal register for the project in accordance with Section 01312A QUALITY CONTROL SYSTEM (QCS).][The Government will provide the initial submittal register in electronic format. Thereafter, the Contractor shall maintain a complete list of all submittals, including completion of all data columns. Dates on

which submittals are received and returned by the Government will be included in its export file to the Contractor. The Contractor shall track all submittals.]

The Designer of Record shall develop a complete list of submittals during design. The Designer of Record shall identify required submittals in the specifications, and use the list to prepare the Submittal Register. The list may not be all inclusive and additional submittals may be required by other parts of the contract. The Contractor is required to complete the submittal register and submit it to the Contracting Officer for approval within 30 calendar days after Notice to Proceed. The approved submittal register will serve as a scheduling document for submittals and will be used to control submittal actions throughout the contract period. The submit dates and need dates used in the submittal register shall be coordinated with dates in the Contractor prepared progress schedule. Updates to the submittal register showing the Contractor action codes and actual dates with Government action codes and actual dates shall be submitted monthly or until all submittals have been satisfactorily completed. When the progress schedule is revised, the submittal register shall also be revised and both submitted for approval.

1.16 SCHEDULING

Submittals covering component items forming a system or items that are interrelated shall be scheduled to be coordinated and submitted concurrently. Certifications to be submitted with the pertinent drawings shall be so scheduled. Adequate time (a minimum of [_____] calendar days exclusive of mailing time) shall be allowed and shown on the register for review and approval. No delay damages or time extensions will be allowed for time lost in late submittals. An additional [_____] calendar days shall be allowed and shown on the register for review and approval of submittals for [food service equipment] [and] [refrigeration and HVAC control systems].

1.17 TRANSMITTAL FORM (ENG FORM 4025)

The sample transmittal form (ENG Form 4025) attached to this section shall be used for submitting both Government approved and information only submittals in accordance with the instructions on the reverse side of the form. These forms [will be furnished to the Contractor][are included in the QCS software that the Contractor is required to use for this contract].

This form shall be properly completed by filling out all the heading blank spaces and identifying each item submitted. Special care shall be exercised to ensure proper listing of the specification paragraph and/or sheet number of the contract drawings pertinent to the data submitted for each item.

1.18 SUBMITTAL PROCEDURES

Submittals shall be made as follows:

1.18.1 Procedures

[_____] [_____] [The Government will further discuss detailed submittal

procedures with the Contractor at the [Preconstruction Conference][Post-Award Conference].

1.18.2 Deviations

For submittals which include proposed deviations requested by the Contractor, the column "variation" of ENG Form 4025 shall be checked. The Contractor shall set forth in writing the reason for any deviations and annotate such deviations on the submittal. The Government reserves the right to rescind inadvertent approval of submittals containing unnoted deviations.

1.19 CONTROL OF SUBMITTALS

The Contractor shall carefully control his procurement operations to ensure that each individual submittal is made on or before the Contractor scheduled submittal date shown on the approved "Submittal Register."

1.20 GOVERNMENT APPROVED SUBMITTALS

Upon completion of review of submittals requiring Government approval, the submittals will be identified as having received approval by being so stamped and dated. [_____] copies of the submittal will be retained by the Contracting Officer and [_____] copies of the submittal will be returned to the Contractor. If the Government performs a conformance review of other Designer of Record approved submittals, the submittals will be so identified and returned, as described above.

1.21 INFORMATION ONLY SUBMITTALS

Normally submittals for information only will not be returned. Approval of the Contracting Officer is not required on information only submittals. The Government reserves the right to 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. For design-build construction the Government will retain [_____] copies of information only submittals.

1.22 STAMPS

Stamps used by the Contractor on the submittal data to certify that the submittal meets contract requirements shall be similar to the following:

<p>CONTRACTOR</p> <p>(Firm Name)</p> <p>_____ Approved</p> <p>_____ Approved with corrections as noted on submittal data and/or attached sheets(s).</p> <p>SIGNATURE: _____</p> <p>TITLE: _____</p> <p>DATE: _____</p>
--

For design-build construction, both the Contractor Quality Control System Manager and the Designer of Record shall stamp and sign to certify that the submittal meets contract requirements.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

Not used.

-- End of Section --

SECTION 01420

SOURCES FOR REFERENCE PUBLICATIONS

PART 1 GENERAL

1.1 REFERENCES

Various publications are referenced in other sections of the specifications to establish requirements for the work. These references are identified in each section by document number, date and title. The document number used in the citation is the number assigned by the standards producing organization, (e.g. ASTM B 564 Nickel Alloy Forgings). However, when the standards producing organization has not assigned a number to a document, an identifying number has been assigned for reference purposes.

1.2 ORDERING INFORMATION

The addresses of the standards publishing organizations whose documents are referenced in other sections of these specifications are listed below, and if the source of the publications is different from the address of the sponsoring organization, that information is also provided. Documents listed in the specifications with numbers which were not assigned by the standards producing organization should be ordered from the source by title rather than by number.

ACI INTERNATIONAL (ACI)
P.O. Box 9094
Farmington Hills, MI 48333-9094
Ph: 248-848-3700
Fax: 248-848-3701
Internet: <http://www.aci-int.org>

AIR CONDITIONING AND REFRIGERATION INSTITUTE (ARI)
4301 North Fairfax Dr., Suite 425
ATTN: Pubs Dept.
Arlington, VA 22203
Ph: 703-524-8800
Fax: 703-528-3816
E-mail: ari@ari.org
Internet: <http://www.ari.org>

AIR CONDITIONING CONTRACTORS OF AMERICA (ACCA)
2800 Shirlington Road, Suite 300
Arlington, VA 22206
Ph: 703-575-4477
FAX: 703-575-4449
Internet: <http://www.acca.org>

AIR DIFFUSION COUNCIL (ADC)
1000 East Woodfield Road, Suite 102

Shaumburg, IL 60173-5921
Ph: 847-706-6750
Fax: 847-706-6751
Internet: <http://www.flexibleduct.org>

AIR MOVEMENT AND CONTROL ASSOCIATION (AMCA)
30 W. University Dr.
Arlington Heights, IL 60004-1893
Ph: 847-394-0150
Fax: 847-253-0088
Internet: <http://www.amca.org>

ALUMINUM ASSOCIATION (AA)

900 19th Street N.W.
Washington, DC 20006
Ph: 202-862-5100
Fax: 202-862-5164
Internet: <http://www.aluminum.org>

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)
1827 Walden Ofc. Sq.
Suite 104
Schaumburg, IL 60173-4268
Ph: 847-303-5664
Fax: 847-303-5774
Internet: <http://www.aamanet.org>

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS
(AASHTO)
444 N. Capital St., NW, Suite 249
Washington, DC 20001
Ph: 800-231-3475 202-624-5800
Fax: 800-525-5562 202-624-5806
Internet: <http://www.aashto.org>

AMERICAN ASSOCIATION OF TEXTILE CHEMISTS AND COLORISTS (AATCC)
P.O. Box 12215
Research Triangle Park, NC 27709-2215
Ph: 919-549-8141
Fax: 919-549-8933
Internet: <http://www.aatcc.org>

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)
2025 M Street, NW, Suite 800
Washington, DC 20036
Ph: 202-367-1155
Fax: 202-367-2155
Internet: <http://www.abma-dc.org>

AMERICAN BOILER MANUFACTURERS ASSOCIATION (ABMA)
4001 North 9th Street, Suite 226
Arlington, VA 22203-1900
Ph: 703-522-7350

Fax: 703-522-2665
Internet: <http://www.abma.com>

AMERICAN CONCRETE PIPE ASSOCIATION (ACPA)
222 West Las Colinas Blvd., Suite 641
Irving, TX 75039-5423
Ph: 972-506-7216 or 800-290-2272
Fax: 972-506-7682
Internet: <http://www.concrete-pipe.org>
e-mail: info@concrete-pipe.org

AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS (ACGIH)
1330 Kemper Meadow Dr.
Suite 600
Cincinnati, OH 45240
Ph: 513-742-2020
Fax: 513-742-3355
Internet: <http://www.acgih.org>
E-mail: pubs@acgih.org

AMERICAN FOREST & PAPER ASSOCIATION (AF&PA)
American Wood Council
ATTN: Publications Dept.
1111 Nineteenth St. NW, Suite 800
Washington, DC 20036
Ph: 800-294-2372 or 202-463-2700
Fax: 202-463-2471
Internet: <http://www.afandpa.org/awc/>

AMERICAN GAS ASSOCIATION (AGA)
400 N. Capitol St. N.W. Suite 450
Washington, D.C. 20001
Ph: 202-824-7000
Fax: 202-824-7115
Internet: <http://www.aga.org>

AMERICAN GAS ASSOCIATION LABORATORIES (AGAL)
400 N. Capitol St. N.W. Suite 450
Washington, D.C. 20001
Ph: 202-824-7000
Fax: 202-824-7115
Internet: <http://www.aga.org>

AMERICAN GEAR MANUFACTURERS ASSOCIATION (AGMA)
1500 King St., Suite 201
Alexandria, VA 22314-2730
Ph: 703-684-0211
Fax: 703-684-0242
Internet: <http://www.agma.org>

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)
One East Wacker Dr., Suite 3100
Chicago, IL 60601-2001
Ph: 312-670-2400

Publications: 800-644-2400
Fax: 312-670-5403
Internet: <http://www.aisc.org>

AMERICAN INSTITUTE OF TIMBER CONSTRUCTION (AITC)
7012 So. Revere Parkway, Suite 140
Englewood, CO 80112
Ph: 303-792-9559
Fax: 303-792-0669
Internet: <http://www.aitc-glulam.org>

AMERICAN IRON AND STEEL INSTITUTE (AISI)
1101 17th St., NW Suite 1300
Washington, DC 20036
Ph: 202-452-7100
Internet: <http://www.steel.org>

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)
1819 L Street, NW, 6th Floor
Washington, DC 20036
Ph: 202-293-8020
Fax: 202-293-9287
Internet: <http://www.ansi.org/>

Note --- Documents beginning with the letter "S" can be ordered from:

Acoustical Society of America
Standards and Publications Fulfillment Center
P. O. Box 1020
Sewickley, PA 15143-9998
Ph: 412-741-1979
Fax: 412-741-0609
Internet: <http://asa.aip.org>
General e-mail: asa@aip.org
Publications e-mail: asapubs@abdintl.com

AMERICAN NURSERY AND LANDSCAPE ASSOCIATION (ANLA)
1250 I St., NW, Suite 500
Washington, DC 20005-3922
Ph: 202-789-2900
FAX: 202-789-1893
Internet: <http://www.anla.org>

AMERICAN PETROLEUM INSTITUTE (API)
1220 L St., NW
Washington, DC 20005-4070
Ph: 202-682-8000
Fax: 202-682-8223
Internet: <http://www.api.org>

AMERICAN PUBLIC HEALTH ASSOCIATION (APHA)
800 I Street, NW
Washington, DC 20001

PH: 202-777-2742
FAX: 202-777-2534
Internet: <http://www.apha.org>

AMERICAN RAILWAY ENGINEERING & MAINTENANCE-OF-WAY ASSOCIATION
(AREMA)
8201 Corporate Dr., Suite 1125
Landover, MD 20785-2230
Ph: 301-459-3200
Fax: 301-459-8077
Internet: <http://www.arema.org>

AMERICAN SOCIETY FOR NONDESTRUCTIVE TESTING (ASNT)
1711 Arlingate Lane
P.O. Box 28518
Columbus, OH 43228-0518
Ph: 800-222-2768
Fax: 614-274-6899
Internet: <http://www.asnt.org>

AMERICAN SOCIETY FOR QUALITY (ASQ)
600 North Plankinton Avenue
Milwaukee, WI 53202-3005
Ph: 800-248-1946
Fax: 414-272-1734
Internet: <http://www.asq.org>

ASTM INTERNATIONAL (ASTM)

100 Barr Harbor Drive
West Conshohocken, PA 19428-2959
Ph: 610-832-9585
Fax: 610-832-9555
Internet: <http://www.astm.org>

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)
1801 Alexander Bell Drive
Reston, VA 20191-4400
Ph: 703-295-6300 - 800-548-2723
Fax: 703-295-6222
Internet: <http://www.asce.org>
e-mail: marketing@asce.org

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING
ENGINEERS (ASHRAE)
1791 Tullie Circle, NE
Atlanta, GA 30329
Ph: 800-527-4723 or 404-636-8400
Fax: 404-321-5478
Internet: <http://www.ashrae.org>

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)
901 Canterbury, Suite A
Westlake, OH 44145

Ph: 440-835-3040
Fax: 440-835-3488
E-mail: asse@ix.netcom.com
Internet: <http://www.asse-plumbing.org>

AMERICAN WATER WORKS ASSOCIATION(AWWA)
6666 West Quincy
Denver, CO 80235
Ph: 800-926-7337 - 303-794-7711
Fax: 303-794-7310
Internet: <http://www.awwa.org>

AMERICAN WELDING SOCIETY (AWS)
550 N.W. LeJeune Road
Miami, FL 33126
Ph: 800-443-9353 - 305-443-9353
Fax: 305-443-7559
Internet: <http://www.amweld.org>

AMERICAN WOOD-PRESERVERS' ASSOCIATION (AWPA)
P.O. Box 5690
Grandbury, TX 76049-0690
Ph: 817-326-6300
Fax: 817-326-6306
Internet: <http://www.awpa.com>

APA - THE ENGINEERED WOOD ASSOCIATION (APA)
P.O.Box 11700
Tacoma, WA 98411-0700
Ph: 253-565-6600
Fax: 253-565-7265
Internet: <http://www.apawood.org>

ARCHITECTURAL & TRANSPORTATION BARRIERS COMPLIANCE BOARD (ATBCB)

The Access Board
1331 F Street, NW, Suite 1000
Washington, DC 20004-1111
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FAX: 202-272-5447
Internet: <http://www.access-board.gov>

ARCHITECTURAL WOODWORK INSTITUTE (AWI)
1952 Isaac Newton Square West
Reston, VA 20190
Ph: 703-733-0600
Fax: 703-733-0584
Internet: <http://www.awinet.org>

ASBESTOS CEMENT PIPE PRODUCERS ASSOCIATION (ACPPA)
PMB114-1745 Jefferson Davis Highway
Arlington, VA 22202
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Fax: 514-861-1152

Internet: None

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New York, NY 10016-5990
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Internet: <http://www.asme.org>

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Research Park Dr.
P.O. Box 14052
Lexington, KY 40512-4052
Ph: 859-288-4960
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1518 K St., NW, Suite 503
Washington, DC 20005
Ph: 202-737-0202
Fax: 202-638-4833
Internet: <http://www.aabchq.com>
E-mail: aabchq@aol.com

ASSOCIATION FOR THE ADVANCEMENT OF MEDICAL INSTRUMENTATION (AAMI)
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Ph: 1-8001-332-2264 or 703-525-4890
Fax: 703-276-0793
Internet: <http://www.aami.org>

ASSOCIATION OF EDISON ILLUMINATING COMPANIES (AEIC)
600 No. 18th St.
P.O. Box 2641
Birmingham, AL 35291
Ph: 205-257-2530
Fax: 205-257-2540
Internet: <http://www.aeic.org>

ASSOCIATION OF HOME APPLIANCE MANUFACTURERS (AHAM)
1111 19th St. NW., Suite 402

Washington, DC 20036
Ph: 202-872-5955
Fax: 202-872-9354
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2680 Horizon Drive SE, Suite A-1
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Fax: 703-620-3928
Internet: <http://www.brickinfo.org>

BRITISH STANDARDS INSTITUTE (BSI)
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London W4 4AL
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Phone: +44 (0)20 8996 9000
Fax: +44 (0)20 8996 7400
Email: Info@bsi-global.com
Website: <http://www.bsi-global.com>

BUILDERS HARDWARE MANUFACTURERS ASSOCIATION (BHMA)
355 Lexington Ave.
17th floor
New York, NY 10017-6603
Ph: 212-297-2122
Fax: 212-370-9047
Internet: <http://www.buildershardware.com>

CARPET AND RUG INSTITUTE (CRI)
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Dalton, GA 30720
P.O. Box 2048
Dalton, GA 30722-2048
Ph: 1-800-882-3176 or 706-278-0232
Fax: 706-278-8835
Internet: <http://www.carpet-rug.com>

CAST IRON SOIL PIPE INSTITUTE (CISPI)
5959 Shallowford Rd., Suite 419
Chattanooga, TN 37421
Ph: 423-892-0137
Fax: 423-892-0817
Internet: <http://www.cispi.org>

CEILINGS & INTERIOR SYSTEMS CONSTRUCTION ASSOCIATION (CISCA)
1500 Lincoln Highway, Suite 202
St. Charles, IL 60174
Ph: 630-584-1919
Fax: 630-584-2003
Internet: <http://www.cisca.org>

CENTERS FOR DISEASE CONTROL AND PREVENTION (CDC)

1600 Clifton Road
Atlanta, GA 30333
PH: 404-639-3311
FAX:
Internet: <http://www.cdc.gov>

CHEMICAL FABRICS & FILM ASSOCIATION (CFFA)

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Cleveland OH 44115-2851
PH: 216-241-7333
FAX: 216-241-0105
Internet: <http://www.chemicalfabricsandfilm.com/>
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2001 L St., NW Suite 506
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Fax: 202-223-7225
Internet: <http://www.cl2.com>

COMPRESSED AIR AND GAS INSTITUTE (CAGI)

1300 Sumner Ave.
Cleveland OH 44115-2851
PH: 216-241-7333
FAX: 216-241-0105
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COMPRESSED GAS ASSOCIATION (CGA)
4221 Walney Road, 5th Floor
Chantilly, VA 20151-2923
Ph: 703-788-2700
Fax: 703-961-1831
Internet: <http://www.cganet.com>
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CONCRETE REINFORCING STEEL INSTITUTE (CRSI)
933 N. Plum Grove Rd.
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Internet: <http://www.crsi.org/>

CONSUMER PRODUCT SAFETY COMMISSION (CPSC)
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Bethesda, Maryland 20814-4408
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Fx: 301-504-0124 and 301-504-0025
Internet: <http://www.cpsc.gov>

CONVEYOR EQUIPMENT MANUFACTURERS ASSOCIATION (CEMA)
6724 Lone Oak Blvd.
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Ph: 941-514-3441
Fax: 941-514-3470
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COOLING TECHNOLOGY INSTITUTE (CTI)
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Fax: 281-537-1721
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COPPER DEVELOPMENT ASSOCIATION (CDA)
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Fax: 212-251-7234
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E-mail: staff@cda.copper.org

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Fx: 704-676-1199
Internet: http://www.mhia.org/psc/psc_products_cranes.cfm

DISTRICT OF COLUMBIA MUNICIPAL REGULATIONS (DCMR)

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e-mail: dasma@dasma.com

DOOR AND HARDWARE INSTITUTE (DHI)
14150 Newbrook Dr. Suite 200
Chantilly, VA 20151-2223
Ph: 703-222-2010
Fax: 703-222-2410
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e-mail: techdept@dhi.org

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Birmingham, AL 35244
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E-mail: info@dipra.org

EIFS INDUSTRY MEMBERS ASSOCIATION (EIMA)
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Morrow, GA 30260
Ph: 800-294-3462
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Boca Raton, FL 33432
Ph: 561-750-5575
Fax: 561-395-8557
Internet: <http://www.egsa.org>

ELECTRONIC INDUSTRIES ALLIANCE (EIA)
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Arlington, VA 22201-3834
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Fax: 703-907-7501
Internet: <http://www.eia.org>

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Successor Organization is Department of Energy
PH:
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E-mail: info@etlsemko.com

EUROPEAN COMMITTEE FOR ELECTROTECHNICAL STANDARDIZATION (CENELEC)
CENELEC CS Info & Publications Department
Rue de Stassartstraat 35
1050 Brussels
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Fax: + 32 2 519 69 19
Internet: <http://www.cenelec.org>

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994 Old Eagle School Road #1019
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PH: 610-971-4850
FAX: 610-9971-4859
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E-mail: info@fluidsealing.com

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HARDWOOD PLYWOOD & VENEER ASSOCIATION (HPVA)

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Fax: 703-435-2537
Internet: <http://www.hpva.org>

HEAT EXCHANGE INSTITUTE (HEI)

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email: hei@heatexchange.org

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INDUSTRIAL FASTENERS INSTITUTE (IFI)
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Cleveland, OH 44114-2879
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Fax: 202-331-1388
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Internet: <http://icac.com>

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)
445 Hoes Ln, P. O. Box 1331
Piscataway, NJ 08855-1331
Ph: 732-981-0060 OR 800-701-4333
Fax: 732-981-9667
Internet: <http://www.ieee.org>
E-mail: customer.services@ieee.org

INSTITUTE OF ENVIRONMENTAL SCIENCES AND TECHNOLOGY (IEST)
940 East Northwest Highway
Mount Prospect, IL 60056
Ph: 847-255-1561
Fax: 847-255-1699
Internet: <http://www.iest.org>

INSULATED CABLE ENGINEERS ASSOCIATION (ICEA)
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Carrollton, GA 30117
Ph: 770-830-0369
Fax: 770-830-8501
E-mail:
Internet: <http://www.icea.net>

INTERNATIONAL APPROVAL SERVICES (IAS)
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Cleveland, OH 44131
Ph: 216-524-4990
Fax: 216-328-8118
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INTERNATIONAL ASSOCIATION OF PLUMBING AND MECHANICAL OFFICIALS
(IAPMO)
20001 East Walnut Dr., So.
Walnut, CA 91789-2825

Ph: 909-595-8449
Fax: 909-594-3690
Fax for Stds: 909-594-5265
Internet: <http://www.iapmo.org>

INTERNATIONAL CODE COUNCIL (ICC)
5203 Leesburg Pike, Suite 600
Falls Church, VA 22041
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Fax: 703-379-1546
Internet: <http://www.intlcode.org>

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Des Plaines, IL 60018
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5360 Workman Mill Rd.
Whittier, CA 90601-2298
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Fax: 562-692-3853
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INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

P.O. Box 687
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Morrison, Colorado 80465
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FAX: 303-697-8431
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INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)
3, rue de Varembe, P.O. Box 131
CH-1211 Geneva 20, Switzerland
Ph: 41-22-919-0211
Fax: 41-22-919-0300
Internet: <http://www.iec.ch>
e-mail: info@iec.ch

INTERNATIONAL GROUND SOURCE HEAT PUMP ASSOCIATION (IGSHPA)

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490 Cordell South
Stillwater OK 74078-8018
PH: 800-626-4747
FAX: 405-744-5283
Internet: <http://www.igshpa.okstate.edu/>

INTERNATIONAL INSTITUTE OF AMMONIA REFRIGERATION (IIAR)
1110 N. Glebe Rd., Suite 250
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Ph: 703-312-4200
Fax: 703-312-0065
Internet: <http://www.iiar.org>
e-mail: iiar@iiar.org

INTERNATIONAL MUNICIPAL SIGNAL ASSOCIATION (IMSA)
P.O. Box 539
165 East Union St.
Newark, NY 14513-0539
Ph: 315-331-2182
Ph: 800-723-4672
Fax: 315-331-8205
Internet: <http://www.imsasafety.org/>

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)
1, rue de Varembe'
Case Postale 56
CH-1211 Geneve 20 Switzerland
Ph: 41-22-749-0111
Fax: 41-22-733-3430
Internet: <http://www.iso.ch>
e-mail: central@iso.ch

INTERNATIONAL SLURRY SURFACING ASSOCIATION (ISSA)
3 Church Circle, PMB 250
Annapolis, MD 21401
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Internet: <http://www.itu.org>

IPC - ASSOCIATION CONNECTING ELECTRONICS INDUSTRIES (IPC)
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Northbrook, IL 60062-6135
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IRON & STEEL SOCIETY (ISS)
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Warrendale, PA 15086-7528
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Internet: <http://www.issource.org>

ISA - THE INSTRUMENTATION, SYSTEMS AND AUTOMATION SOCIETY (ISA)
67 Alexander Drive
P.O. Box 12277
Research Triangle Park, NC 27709
Ph: 919-549-8411
Fax: 919-549-8288
e-mail: info@isa.org
Internet: <http://www.isa.org>

KITCHEN CABINET MANUFACTURERS ASSOCIATION (KCMA)
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Reston, VA 20191-5435
Ph: 703-264-1690
Fax: 703-620-6530
Internet: <http://www.kcma.org>

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c/o Cornell University
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Vienna, VA 22180-4602
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Fax: 703-281-6671
Internet: <http://www.mss-hq.com>
e-mail: info@mss-hq.com

MAPLE FLOORING MANUFACTURERS ASSOCIATION (MFMA)
60 Revere Dr., Suite 500
Northbrook, IL 60062

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Fax: 847-480-9282
Internet: <http://www.maplefloor.org>

MARBLE INSTITUTE OF AMERICA (MIA)
30 Eden Alley, Suite 301
Columbus, OH 43215
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Fax: 614-461-1497
Internet: <http://www.marble-institute.com>
e-mail: info@marble-institute.com

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4090 Graveley Street
Burnaby, BC CANADA V5C 3T6
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Fx: 888-211-8708
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METAL BUILDING MANUFACTURERS ASSOCIATION (MBMA)
1300 Sumner Ave.
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Ph: 216-241-7333
Fax: 216-241-0105
Internet: <http://www.mbma.com>
e-mail: mbma@mbma.com

METAL LATH/STEEL FRAMING ASSOCIATION (ML/SFA)

NAAMM Headquarters
8 South Michigan Avenue, Suite 1000
Chicago, IL 60603
PH: 312-332-0405
FAX: 312-332-0706
Internet: <http://www.naamm.org/mlsfa.htm>

NOTE --- ML/SFA has merged with NAAMM.

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2017 So. 139th Cir.
Omaha, NE 68144
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e-mail: info@micainsulation.org

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8720 Red Oak Blvd., Suite 201
Charlotte, NC 28217
PH: 704-676-1190
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Internet: <http://www.mhia.org/>

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U.S. NAVAL FACILITIES ENGINEERING COMMAND (NAVFAC)
1510 Gilbert St.
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Ph: 757-322-4200
Fax: 757-322-4416
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1100 23rd Avenue
Port Hueneme, CA 93043-4370
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Internet: <http://www.nfesc.navy.mil>

WATER ENVIRONMENT FEDERATION (WEF)
601 Wythe St.
Alexandria, VA 22314-1994
Ph: 703-684-2452
Fax: 703-684-2492
Internet: <http://www.wef.org>

WATER QUALITY ASSOCIATION (WQA)
4151 Naperville Rd.
Lisle, IL 60532
Ph: 630-505-0160
Fax: 630-505-9637
Internet: <http://www.wqa.org>
e-mail: info@mail.wqa.org

WEST COAST LUMBER INSPECTION BUREAU (WCLIB)
P.O. Box 23145
Portland, OR 97281
Ph: 503-639-0651
Fax: 503-684-8928
Internet: <http://www.wclib.org>
e-mail: info@wclib.org

WESTERN WOOD PRESERVERS INSTITUTE (WWPI)
7017 N.E. Highway 99 # 108
Vancouver, WA 98665
Ph: 360-693-9958
Fax: 360-693-9967
Internet: <http://www.wwpinstitute.org>
e-mail: info@wwpinstitute.org

WESTERN WOOD PRODUCTS ASSOCIATION (WWPA)
Yeon Bldg.
522 SW 5th Ave.
Suite 500
Portland, OR 97204-2122
Ph: 503-224-3930
Fax: 503-224-3934
Internet: <http://www.wwpa.org>
e-mail: info@wwpa.org

WINDOW AND DOOR MANUFACTURERS ASSOCIATION (WDMA)
1400 East Touhy Ave., Suite 470
Des Plaines, IL 60018
Ph: 847-299-5200 or 800-223-2301
Fax: 708-299-1286
Internet: <http://www.wdma.com>

e-mail: admin@wdma.com

WOOD MOULDING AND MILLWORK PRODUCERS ASSOCIATION (WMPA)
507 First Street
Woodland, CA 95695
Ph: 530-661-9591 or 800-550-7889
Fax: 530-661-9586
Internet: <http://www.wmpa.com>

-- End of Section --

01450N

QUALITY CONTROL

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 in the text by the basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 880	(1995) Criteria for Use in Evaluation of Testing Laboratories and Organization for Examination and Inspection of Steel, Stainless Steel, and Related Alloys
ASTM C 1077	(1998) Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation
ASTM E 329	(2000; Rev. A) Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction
ASTM E 543	(1999) Agencies Performing Nondestructive Testing

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(1996) Safety and Health Requirements Manual
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1.2 SUBMITTALS

Submit the following in accordance with Section 01330, "Submittal Procedures."

SD-01 Preconstruction Submittals

Quality Control (QC) plan; G

Submit a QC plan within 20 calendar days after receipt of Notice of Award.

The QC Plan shall include a preliminary submittal of the list of definable features of work that shall cover the first 90 days of construction.

Submit the completed list of definable features of work in conjunction with the Accepted Schedule.

Any approval by the Government of the QC Plan shall be considered to be "approved as noted, resubmittal required" and will be in effect only until the completed list of definable features of work is received and approved.

1.3 INFORMATION FOR THE CONTRACTING OFFICER

Prior to commencing work on construction, the Contractor can obtain a single copy set of the current report forms from the Contracting Officer, or by calling the local EFD/EFA QA Coordinator for an electronic version of the report forms. The report forms will consist of the Contractor Production Report, Contractor Production Report (Continuation Sheet), Contractor Quality Control Report, Contractor Quality Control Report (Continuation Sheet), Preparatory Phase Checklist, Initial Phase Checklist, Rework Items List, and Testing Plan and Log. Other reports referenced below may be in formats customarily used by the Contractor, Testing Laboratories, etc. and will contain the information required by this specification.

Deliver the following to the Contracting Officer:

- a. Contractor Quality Control Report; original and 1 copy, by 10:00 AM the next working day after each day that work is performed.
- b. Contractor Production Report: Original and 1 copy, by 10:00 AM the next working day after each day that work is performed, attached to the Contractor Quality Control Report.
- c. Preparatory Phase Checklist: Original attached to the original Contractor Quality Control Report and 1 copy attached to each copy.
- d. Initial Phase Checklist: Original attached to the original Contractor Quality Control Report and 1 copy attached to each copy.
- e. Field Test Reports: 2 copies, within 2 working days after the test is performed, attached to the Contractor Quality Control Report.
- f. Monthly Summary Report of Tests: 2 copies attached to the Contractor Quality Control Report.
- g. Testing Plan and Log, 2 copies, at the end of each month.
- h. Rework Items List: 2 copies, by the last working day of the month.
- i. QC Meeting Minutes: 2 copies, within 2 working days after the meeting.
- j. QC Certifications: As required by the paragraph entitled "QC Certifications."

1.4 QC PROGRAM REQUIREMENTS

Establish and maintain a QC program as described in this section. The QC program consists of a QC Organization, a QC Plan, a QC Plan Meeting, a Coordination and Mutual Understanding Meeting, QC meetings, three phases of control, submittal review and approval, testing, completion inspections, and QC certifications and documentation necessary to provide materials, equipment, workmanship, fabrication, construction and operations which comply with the requirements of this Contract. The QC program shall cover on-site and off-site work and shall be keyed to the work sequence. No work or testing may be performed unless the QC Manager is on the work site. The QC Manager shall report to an officer of the firm and shall not be subordinate to the Project Superintendent or the Project Manager. The QC Manager, Project Superintendent and Project Manager must work together effectively. Although the Quality Control Manager is the primary individual responsible for quality control, all three individuals will be held responsible for the quality of work on the job. The project superintendent will be held responsible for the quality of production.

1.4.1 Preliminary Work Authorized Prior to Approval

The only work that is authorized to proceed prior to the approval of the QC Plan is mobilization of storage and office trailers, temporary utilities, and surveying.

1.4.2 Approval

Approval of the QC Plan is required prior to the start of construction. The Contracting Officer reserves the right to require changes in the QC Plan and operations as necessary, including removal of personnel, to ensure the specified quality of work. The Contracting Officer reserves the right to interview any member of the QC organization at any time in order to verify the submitted qualifications. All QC organization personnel shall be subject to acceptance by the Contracting Officer. The Contracting Officer may require the removal of any individual for non-compliance with quality requirements specified in the contract.

1.4.3 Notification of Changes

Notify the Contracting Officer, in writing, of any proposed change, including changes in the QC organization personnel, a minimum of seven calendar days prior to a proposed change. Proposed changes shall be subject to acceptance by the Contracting Officer.

1.5 QC ORGANIZATION

1.5.1 QC Manager

1.5.1.1 Duties

Provide a QC Manager at the work site to implement and manage the QC program. In addition to implementing and managing the QC program, the QC Manager may perform the duties of project superintendent. The QC Manager

is required to attend the QC Plan Meeting, attend the Coordination and Mutual Understanding Meeting, conduct the QC meetings, perform the three phases of control, perform submittal review and approval, ensure testing is performed and provide QC certifications and documentation required in this contract. The QC Manager is responsible for managing and coordinating the three phases of control and documentation performed by Testing Laboratory personnel and any other inspection and testing personnel required by this Contract.

1.5.1.2 Qualifications

An individual with a minimum of 10 years experience as a superintendent, inspector, QC Manager, project manager, project engineer or construction manager on similar size and type construction contracts which included the major trades that are part of this Contract. The individual must be familiar with the requirements of EM 385-1-1, and have experience in the areas of hazard identification and safety compliance.

1.5.1.3 Construction Quality Management Training

In addition to the above experience and education requirements, the QC Manager shall have completed the course entitled "Construction Quality Management for Contractors." If the QC Manager does not have a current certification, they shall obtain the CQM course certification within 90 days of award. This one-day course is periodically offered in alternate months by : (1) the Maryland Chapter, Associated General Contractors (AGC), 410-321-7870; agcmd@aol.com and by (2) the Virginia Chapter, Associated Builders and Contractors (ABC), 703-968-6205, joanna@abdva.org; mervin@abc.org. The training uses Army Corps of engineers course content. The course is facilitated by instructors from Army Corps of Engineers, North Atlantic Division, Balitmore District, and by instructors from the Naval Facilities Engineering Command, Engineering Field Activity Chesapeake.

1.5.2 Alternate QC Manager Duties and Qualifications

Designate an alternate for the QC Manager at the work site to serve in the event of the designated QC Manager's absence. The period of absence may not exceed two weeks at one time, and not more than 30 workdays during a calendar year. The qualification requirements for the Alternate QC Manager shall be the same as for the QC manager.

1.6 QUALITY CONTROL (QC) PLAN

1.6.1 Requirements

Provide, for approval by the Contracting Officer, a QC plan submitted in a 3-ring binder with pages numbered sequentially that covers both on-site and off-site work and includes the following:

- a. A table of contents listing the major sections identified with tabs in the following order:

- I. QC ORGANIZATION
- II. NAMES AND QUALIFICATIONS

- III. DUTIES, RESPONSIBILITY AND AUTHORITY OF QC PERSONNEL
 - IV. OUTSIDE ORGANIZATIONS
 - V. APPOINTMENT LETTERS
 - VI. SUBMITTAL PROCEDURES AND INITIAL SUBMITTAL REGISTER
 - VII. TESTING LABORATORY INFORMATION
 - VIII. TESTING PLAN AND LOG
 - IX. PROCEDURES TO COMPLETE REWORK ITEMS
 - X. DOCUMENTATION PROCEDURES
 - XI. LIST OF DEFINABLE FEATURES
 - XII. PROCEDURES FOR PERFORMING THE THREE PHASES OF CONTROL
-
- b. A chart showing the QC organizational structure.
 - c. Names and qualifications, in resume format, for each person in the QC organization. Include the CQM course certifications for the QC Manager and Alternate QC Manager as required by the paragraphs entitled "Construction Quality Management Training" and "Alternate QC Manager Duties and Qualifications".
 - d. Duties, responsibilities and authorities of each person in the QC organization.
 - e. A listing of outside organizations such as, architectural and consulting engineering firms that will be employed by the Contractor and a description of the services these firms will provide.
 - f. Letters signed by an officer of the firm appointing the QC Manager and Alternate QC Manager and stating that they are responsible for implementing and managing the QC program as described in this contract. Include in this letter the responsibility of the QC Manager and Alternate QC Manager to implement and manage the three phases of quality control, and their authority to stop work which is not in compliance with the contract. The QC Manager shall issue letters of direction to the Assistant QC Manager and all other QC specialists outlining their duties, authorities, and responsibilities. Copies of the letters shall be included in the QC plan.
 - g. Procedures for reviewing, approving and managing submittals. Provide the name of the person in the QC organization authorized to review and certify submittals prior to approval. Provide the initial submittal of the Submittal Register as specified in section entitled "Submittal Procedures."
 - h. Testing laboratory information required by the paragraphs entitled "Accreditation Requirements" or "Construction Materials Testing Laboratory Requirements", as applicable.
 - i. A Testing Plan and Log that includes the tests required, referenced by the specification paragraph number requiring the test, the frequency, and the person responsible for each test.
 - j. Procedures to identify, record, track and complete rework items.

- k. Documentation procedures, including proposed report formats.
- l. List of definable features of work. A definable feature of work (DFOW) is a task which is separate and distinct from other tasks, has the same control requirements and work crews. The list shall be cross-referenced to the contractor's Construction Schedule and the specification sections. For projects requiring a Progress Chart, the list of definable features of work shall include but not be limited to all items of work on the schedule. For projects requiring a Network Analysis Schedule, the list of definable features of work shall include but not be limited to all critical path activities.
- m. Procedures for Performing the Three Phases of Control. For each DFOW, provide the DFOW's Preparatory and Initial Phase Checklists. Each list shall include a breakdown of quality checks that will be used when performing the quality control functions, inspections, and tests required by the contract documents. The Preparatory and Initial Phases and meetings shall be conducted with a view towards obtaining quality construction by planning ahead and identifying potential problems for each definable feature of work.

1.7 QC PLAN MEETING

Prior to submission of the QC plan, meet with the Contracting Officer to discuss the QC plan requirements of this Contract. The purpose of this meeting is to develop a mutual understanding of the QC plan requirements prior to plan development and submission.

1.8 COORDINATION AND MUTUAL UNDERSTANDING MEETING

After submission of the QC Plan, and prior to the start of construction, meet with the Contracting Officer to present the QC program required by this Contract. The purpose of this meeting is to develop a mutual understanding of the QC details, including documentation, administration for on-site and off-site work, and the coordination of the Contractor's management, production and QC personnel. At the meeting, the Contractor will be required to explain in detail how three phases of control will be implemented for each definable feature of work. As a minimum, the Contractor's personnel required to attend shall include an officer of the firm, the project manager, project superintendent, QC Manager, Alternate QC Manager and subcontractor representatives. Each subcontractor who will be assigned QC responsibilities shall have a principal of the firm at the meeting. Minutes of the meeting will be prepared by the QC Manager and signed by the Contractor, and the Contracting Officer. A copy of the signed minutes shall be provided to all attendees by the Contractor. Repeat the coordination and mutual understanding meeting when a new QC Manager is appointed.

1.9 QC MEETINGS

After the start of construction, the QC Manager shall conduct weekly QC

meetings at the work site with the project superintendent. The QC Manager shall prepare the minutes of the meeting and provide a copy to the Contracting Officer within 2 working days after the meeting. The Contracting Officer may attend these meetings. The QC Manager shall notify the Contracting Officer at least 48 hours in advance of each meeting. As a minimum, the following shall be accomplished at each meeting:

- a. Review the minutes of the previous meeting;
- b. Review the schedule and the status of work:
 - (1) Work or testing accomplished since last meeting
 - (2) Rework items identified since last meeting
 - (3) Rework items completed since last meeting;
- c. Review the status of submittals:
 - (1) Submittals reviewed and approved since last meeting
 - (2) Submittals required in the near future;
- d. Review the work to be accomplished in the next 2 weeks and documentation required:
 - (1) Establish completion dates for rework items
 - (2) Update the schedule showing planned and actual dates of the preparatory, initial and follow-up phases, including testing and any other inspection required by this contract
 - (3) Discuss construction methods and the approach that will be used to provide quality construction by planning ahead and identifying potential problems for each definable feature of work
 - (4) Discuss status of off-site work or testing
 - (5) Documentation required;
 - (6) Discuss upcoming Activity Hazard Analyses:
- e. Resolve QC and production problems:
 - (1) Assist in resolving Request for Information issues; and
- f. Address items that may require revising the QC plan:
 - (1) Changes in QC organization personnel
 - (2) Changes in procedures.
- g. Review health and safety plan

1.10 THREE PHASES OF CONTROL

The Three Phases of Control shall adequately cover both on-site and off-site work and shall include the following for each definable feature of work.

1.10.1 Preparatory Phase

Notify the Contracting Officer at least 2 work days in advance of each preparatory phase. This phase shall include a meeting conducted by the QC Manager and attended by the superintendent, and the foreman responsible for the definable feature. Document the results of the preparatory phase actions in the daily Contractor Quality Control Report and in the Preparatory Phase Checklist. Perform the following prior to beginning work on each definable feature of work:

- a. Review each paragraph of the applicable specification sections;
- b. Review the Contract drawings;
- c. Verify that appropriate shop drawings and submittals for materials and equipment have been submitted and approved. Verify receipt of approved factory test results, when required;
- d. Review the testing plan and ensure that provisions have been made to provide the required QC testing;
- e. Examine the work area to ensure that the required preliminary work has been completed;
- f. Examine the required materials, equipment and sample work to ensure that they are on hand and conform to the approved shop drawings and submitted data;
- g. Discuss construction methods, construction tolerances, workmanship standards, and the approach that will be used to provide quality construction by planning ahead and identifying potential problems for each definable feature of work; and
- h. Review the safety plan and appropriate activity hazard analysis to ensure that applicable safety requirements are met, and that required Material Safety Data Sheets (MSDS) are submitted.

1.10.2 Initial Phase

Notify the Contracting Officer at least 2 work days in advance of each initial phase. When construction crews are ready to start work on a definable feature of work, conduct the initial phase with, the superintendent, and the foreman responsible for that definable feature of work. Observe the initial segment of the definable feature of work to ensure that the work complies with Contract requirements. Document the results of the initial phase in the daily Contractor Quality Control Report and in the Initial Phase Checklist. Repeat the initial phase for each new crew to work on-site, or when acceptable levels of specified quality are

not being met. Perform the following for each definable feature of work:

- a. Establish the quality of workmanship required;
- b. Resolve conflicts;
- c. Ensure that testing is performed, and
- d. Check work procedures for compliance with the Safety Plan and the appropriate activity hazard analysis to ensure that applicable safety requirements are met.

1.10.3 Follow-Up Phase

Perform the following for on-going work daily, or more frequently as necessary until the completion of each definable feature of work and document in the daily Contractor Quality Control Report:

- a. Ensure the work is in compliance with Contract requirements;
- b. Maintain the quality of workmanship required;
- c. Ensure that testing is performed;
- d. Ensure that rework items are being corrected; and
- e. Perform safety inspections.

1.10.4 Additional Preparatory and Initial Phases

Additional Preparatory and Initial Phases shall be conducted on the same definable features of work if the quality of on-going work is unacceptable, if there are changes in the applicable QC organization, if there are changes in the on-site production supervision or work crew, if work on a definable feature is resumed after substantial period of inactivity, or if other problems develop.

1.10.5 Notification of Three Phases of Control for Off-Site Work

Notify the Contracting Officer at least two weeks prior to the start of the preparatory and initial phases.

1.11 SUBMITTAL REVIEW AND APPROVAL

Procedures for submission, review and approval of submittals are described in section entitled "Submittal Procedures."

1.12 TESTING

Except as stated otherwise in the specification sections, perform sampling and testing required under this Contract.

1.12.1 Accreditation Requirements

Construction materials testing laboratories performing work for Navy construction contracts will be required to submit the following:

- a. A copy of the Certificate of Accreditation and Scope of Accreditation by an acceptable laboratory accreditation authority.

Construction materials testing laboratories performing work for Navy construction contracts must be accredited by one of the laboratory accreditation authorities. The laboratory's scope of accreditation must include the ASTM standards listed in the paragraph titled "Construction Materials Testing Laboratory Requirements" as appropriate to the testing field. The policy applies to the specific laboratory performing the actual testing, not just the "Corporate Office".

1.12.2 Construction Materials Testing Laboratory Requirements

Provide an independent construction materials testing laboratory accredited by an acceptable laboratory accreditation authority to perform sampling and tests required by this Contract. Testing laboratories that have obtained accreditation by an acceptable laboratory accreditation authority listed in the paragraph entitled "Laboratory Accreditation Authorities" submit to the Contracting Officer, a copy of the Certificate of Accreditation and Scope of Accreditation. The scope of the laboratory's accreditation shall include the test methods required by the Contract. For testing laboratories that have not yet obtained accreditation by an acceptable laboratory accreditation authority listed in the paragraph entitled "Laboratory Accreditation Authorities" submit an acknowledgment letter from one of the laboratory accreditation authorities indicating that the application for accreditation has been received and the accreditation process has started, and submit to the Contracting Officer for approval, certified statements, signed by an official of the testing laboratory attesting that the proposed laboratory, meets or conforms to the ASTM standards listed below as appropriate to the testing field.

- a. Laboratories engaged in testing of construction materials shall meet the requirements of ASTM E 329.
- b. Laboratories engaged in testing of concrete and concrete aggregates shall meet the requirements of ASTM C 1077.
- c. Laboratories engaged in inspection and testing of steel, stainless steel, and related alloys will be evaluated according to ASTM A 880.
- d. Laboratories engaged in nondestructive testing (NDT) shall meet the requirements of ASTM E 543.
- e. Laboratories engaged in Hazardous Materials Testing shall meet the requirements of OSHA and EPA.

1.12.3 Laboratory Accreditation Authorities

Laboratory Accreditation Authorities are the National Voluntary Laboratory Accreditation Program (NVLAP) administered by the National Institute of Standards and Technology, the American Association of State Highway and

Transportation Officials (AASHTO) program, ICBO Evaluation Service, Inc. (ICBO ES), and the American Association for Laboratory Accreditation (A2LA) program and the Washington Association of Building Officials (WABO) (Approval authority for WABO is limited to projects within Washington State), and the Washington Area Council of Engineering Laboratories (WACEL) (Approval authority by WACEL is limited to projects within the Chesapeake Division and Public Works Center Washington geographical area).

Furnish to the Contracting Officer, a copy of the Certificate of Accreditation and Scope of Accreditation. The scope of the laboratory's accreditation shall include the test methods required by the Contract.

1.12.4 Capability Check

The Contracting Officer retains the right to check laboratory equipment in the proposed laboratory and the laboratory technician's testing procedures, techniques, and other items pertinent to testing, for compliance with the standards set forth in this Contract.

1.12.5 Test Results

Cite applicable Contract requirements, tests or analytical procedures used. Provide actual results and include a statement that the item tested or analyzed conforms or fails to conform to specified requirements. If the item fails to conform, notify Contracting Officer immediately. Conspicuously stamp the cover sheet for each report in large red letters "CONFORMS" or "DOES NOT CONFORM" to the specification requirements, whichever is applicable. Test results shall be signed by a testing laboratory representative authorized to sign certified test reports. Furnish the signed reports, certifications, and other documentation to the Contracting Officer via the QC Manager. Furnish a summary report of field tests at the end of each month. Attach a copy of the summary report to the last daily Contractor Quality Control Report of each month.

1.12.6 Test Reports and Monthly Summary Report of Tests

The QC Manager shall furnish the signed reports, certifications, and a summary report of field tests at the end of each month to the Contracting Officer. Attach a copy of the summary report to the last daily Contractor Quality Control Report of each month.

1.13 QC CERTIFICATIONS

1.13.1 Contractor Quality Control Report Certification

Each Contractor Quality Control Report shall contain the following statement: "On behalf of the Contractor, I certify that this report is complete and correct and equipment and material used and work performed during this reporting period is in compliance with the contract drawings and specifications to the best of my knowledge, except as noted in this report."

1.13.2 Invoice Certification

Furnish a certificate to the Contracting Officer with each payment request, signed by the QC Manager, attesting that as-built drawings are current and attesting that the work for which payment is requested, including stored material, is in compliance with contract requirements.

1.13.3 Completion Certification

Upon completion of work under this Contract, the QC Manager shall furnish a certificate to the Contracting Officer attesting that "the work has been completed, inspected, tested and is in compliance with the Contract."

1.14 COMPLETION INSPECTIONS

1.14.1 Punch-Out Inspection

Near the completion of all work or any increment thereof established by a completion time stated in the Contract Clause entitled "Commencement, Prosecution, and Completion of Work," or stated elsewhere in the specifications, the QC Manager shall conduct an inspection of the work and develop a "punch list" of items which do not conform to the approved drawings and specifications. Include in the punch list any remaining items on the "Rework Items List" which were not corrected prior to the Punch-Out Inspection. The punch list shall include the estimated date by which the deficiencies will be corrected. A copy of the punch list shall be provided to the Contracting Officer. The QC Manager or staff shall make follow-on inspections to ascertain that all deficiencies have been corrected. Once this is accomplished the Contractor shall notify the Government that the facility is ready for the Government "Pre-Final Inspection."

1.14.2 Pre-Final Inspection

The Government will perform this inspection to verify that the facility is complete and ready to be occupied. A Government "Pre-Final Punch List" may be developed as a result of this inspection. The QC Manager shall ensure that all items on this list are corrected prior to notifying the Government that a "Final" inspection with the customer can be scheduled. Any items noted on the "Pre-Final" inspection shall be corrected in timely manner and shall be accomplished before the contract completion date for the work or any particular increment thereof if the project is divided into increments by separate completion dates.

1.14.3 Final Acceptance Inspection

The QC Manager, the QC specialists, the superintendent or other primary contractor management personnel, and the Contracting Officer's representative will be in attendance at this inspection. Additional Government personnel may be in attendance. The final acceptance inspection will be formally scheduled by the Contracting Officer based upon results of the "Pre-Final" inspection. Notice shall be given to the Contracting Officer at least 14 days prior to the final inspection stating that all specific items previously identified to the Contractor as being unacceptable, along with all the remaining work performed under the contract, will be complete and acceptable by the date scheduled for the final acceptance inspection. Failure of the Contractor to have all

contract work acceptably complete for this inspection will be cause for the Contracting Officer to bill the Contractor for the Government's additional inspection cost in accordance with the Contract Clause entitled "Inspection of Construction." When the Contracting Officer takes possession of partially completed work, it will be in accordance with Contract Clause "Use and Possession Prior to Completion".

1.15 DOCUMENTATION

Maintain current and complete records of on-site and off-site QC program operations and activities.

1.15.1 Contractor Production Report

Reports are required for each day that work is performed and shall be attached to the Contractor Quality Control Report prepared for the same day. Account for each calendar day throughout the life of the Contract. The reporting of work shall be identified by terminology consistent with the construction schedule. Contractor Production Reports are to be prepared, signed and dated by the project superintendent and shall contain the following information:

- a. Date of report, report number, name of contractor, Contract number, title and location of Contract and superintendent present.
- b. Weather conditions in the morning and in the afternoon including maximum and minimum temperatures.
- c. Identify work performed by corresponding Schedule Activity No., PC#, Modification No., etc.
- d. A list of Contractor and subcontractor personnel on the work site, their trades, employer, work location, description of work performed, hours worked by trade, daily total work hours on work site this date (incl hours on continuation sheets), and total work hours from start of construction.
- e. A list of job safety actions taken and safety inspections conducted. Indicate that safety requirements have been met including the results on the following:
 - (1) Was a job safety meeting held this date? (If YES, attach a copy of the meeting minutes.)
 - (2) Were there any lost time accidents this date? (If YES, attach a copy of the completed OSHA report.)
 - (3) Was crane/manlift/trenching/scaffold/hv electrical/high work/hazmat work done? (If YES, attach a statement or checklist showing inspection performed.)
 - (4) Was hazardous material/waste released into the environment? (If YES, attach a description of incident and proposed action.)

- f. Identify Schedule Activity No. related to safety action and list safety actions taken today and safety inspections conducted.
- g. Identify Schedule Activity No., Submittal # and list equipment/material received each day that is incorporated into the job.
- h. Identify Schedule Activity No., Owner and list construction and plant equipment on the work site including the number of hours used.
- i. Include a "remarks" section in this report which will contain pertinent information including directions received, problems encountered during construction, work progress and delays, conflicts or errors in the drawings or specifications, field changes, safety hazards encountered, instructions given and corrective actions taken, delays encountered and a record of visitors to the work site. For each remark given, identify the Schedule Activity No. that is associated with the remark.

1.15.1.1 Contractor Production Report (Continuation Sheet)

Additional space required to contain daily information on the Contractor Production Report will be placed on its Continuation Sheet(s). An unlimited number of Continuation Sheets may be added as necessary and attached to the Production Report.

1.15.2 Contractor Quality Control Report

Reports are required for each day that work is performed and for every seven consecutive calendar days of no-work and on the last day of a no-work period. Account for each calendar day throughout the life of the Contract.

The reporting of work shall be identified by terminology consistent with the construction schedule. Contractor Quality Control Reports are to be prepared, signed and dated by the QC Manager and shall contain the following information:

- a. Date of report, report number, Contract Number, and Contract Title.
- b. Indicate if Preparatory Phase work was performed today (Yes/No checkboxes).
- c. If Preparatory Phase work was performed today (including on-site and off-site work), identify its Schedule Activity No. and Definable Feature of Work. The Index # is a cross reference to the Preparatory Phase Checklist. An example of the Index # is: 0025-P01, where "0025" is the Contractor Quality Control Report Number, "P" indicates Preparatory Phase, and "01" is the Preparatory Phase Checklist number(s) for this date. Each entry in this section must be accompanied with a corresponding Preparatory Phase Checklist.
- d. Indicate if Initial Phase work was performed today (Yes/No checkboxes).

- e. If Initial Phase work was performed today (including on-site and off-site work), identify its Schedule Activity No. and Definable Feature of Work. The Index # is a cross reference to the Initial Phase Checklist. An example of the Index # is: 0025-I01, where "0025" is the Contractor Quality Control Report Number, "I" indicates Initial Phase, and "01" is the Initial Phase Checklist number(s) for this date. Each entry in this section must be accompanied with a corresponding Initial Phase Checklist.
- f. Results of the Follow-up Phase inspections held today (including on-site and off-site work), including Schedule Activity No., the location of the definable feature of work, Specification Sections, etc. Indicate in the report for this definable feature of work that the work complies with the Contract as approved in the Initial Phase, work complies with safety requirements, and that required testing has been performed and include a list of who performed the tests.
- g. List the rework items identified, but not corrected by close of business; along with its associated Schedule Activity Number.
- h. List the rework items corrected from the rework items list along with the corrective action taken and its associated Schedule Activity Number.
- i. Include a "remarks" section in this report which will contain pertinent information including directions received, quality control problem areas, deviations from the QC plan, construction deficiencies encountered, QC meetings held, acknowledgement that as-built drawings have been updated, corrective direction given by the QC Organization and corrective action taken by the Contractor. For each remark given, identify the Schedule Activity No. that is associated with the remark.
- j. Contractor Quality Control Report certification, signature and date.

1.15.2.1 Contractor Quality Control Report (Continuation Sheet)

Additional space required to contain daily information on the Contractor Quality Control Report will be placed on its Continuation Sheet(s). An unlimited number of Continuation Sheets may be added as necessary and attached to the Contractor Quality Control Report.

1.15.3 Preparatory Phase Checklist

Each Definable Feature of Work that is in the Preparatory Phase shall have this checklist filled out for it. The checklist shall be identified by terminology consistent with the construction schedule. Attach this checklist to the Contractor Quality Control Report of the same date.

- a. Specification Section, date of report, and Contract number shall be filled out. Duplicate this information in the header of the

second page of the report.

- b. Definable Feature of Work, Schedule Activity No. and Index # entry and format will match entry in the Preparatory Phase section of the Contractor Quality Control Report. Duplicate this information in the header of the second page of the report.
- c. Personnel Present: Indicate the number of hours of advance notice that was given to the Government Representative and indicate (Yes/No checkboxes) whether or not the Government Rep was notified. Indicate the Names of Preparatory Phase Meeting attendees, their position and company/government they are with.
- d. Submittals: Indicate if submittals have been approved (Yes/No checkboxes), if no indicate what has not been submitted. Are materials on hand (Yes/No checkboxes) and if not, what items are missing. Check delivered material/equipment against approved submittals and comment as required.
- e. Material Storage: Indicate if materials/equipment is stored properly (Yes/No checkboxes) and if not, what action is/was taken.
- f. Specifications: Review and comment on Specification Paragraphs that describe the material/equipment, procedure for accomplishing the work and clarify any differences.
- g. Preliminary Work & Permits: Ensure preliminary work is in accordance with the contract documents and necessary permits are on file, if not, describe the action taken.
- h. Testing: Identify who performs tests, the frequency, and where tests are to occur. Review the testing plan, report abnormalities, and if the test facilities have been approved.
- i. Safety: Indicate if the activity hazard analysis has been approved (Yes/No checkboxes) and comment on the review of the applicable portions of the EM 385-1-1.
- j. Meeting Comments: Note comments and remarks during the Preparatory Phase Meeting that was not addressed in previous sections of this checklist.
- k. Other Items or Remarks: Note any other remarks or items that were a result of the Preparatory Phase.
- l. QC Manager will sign and date the checklist.

1.15.4 Initial Phase Checklist

Each Definable Feature of Work that is in the Initial Phase shall have this checklist filled out for it. The checklist shall be identified by terminology consistent with the construction schedule. Attach this checklist to the Contractor Quality Control Report of the same date.

- a. Specification Section, date of report, and Contract number shall be entered.
- b. Definable Feature of Work, Schedule Activity No. and Index # entry and format will match entry in the Initial Phase section of the Contractor Quality Control Report.
- c. Personnel Present: Indicate the number of hours of advance notice that was given to the Government Representative and indicate (Yes/No checkboxes) whether or not the Government Rep was notified. Indicate the Names of Initial Phase Meeting attendees, their position and company/government they are with.
- d. Procedure Compliance: Comment on compliance with procedures identified at Preparatory Phase of Control and assurance that work is in accordance with plans, specifications and submittals.
- e. Preliminary Work: Ensure preliminary work being placed is in compliance and if not, what action is/was taken.
- f. Workmanship: Identify where initial work is located; if a sample panel is required (Yes/No checkboxes); is the initial work the sample (Yes/No checkboxes); and if Yes, describe the panel location and precautions taken to preserve the sample.
- g. Resolution: Comment on any differences and the resolutions reached.
- h. Check Safety: Comment on the safety review of the job conditions.
- i. Other: Note any other remarks or items that were a result of the Initial Phase.
- j. QC Manager will sign and date the checklist.

1.15.5 Quality Control Validation

Establish and maintain the following in a series of 3 ring binders. Binders shall be divided and tabbed as shown below. These binders shall be readily available to the Government's Quality Assurance Team during all business hours.

- a. All completed Preparatory and Initial Phase Checklists, arranged by specification section.
- b. All milestone inspections , arranged by Activity/Event Number.
- c. A current up-to-date copy of the Testing and Plan Log with supporting field test reports, arranged by specification section.
- d. Copies of all contract modifications, arranged in numerical order. Also include documentation that modified work was accomplished.
- e. A current up-to-date copy of the Rework Items List.

- f. Maintain up-to-date copies of all punch lists issued by the QC Staff on the Contractor and Sub-Contractors and all punch lists issued by the Government.

1.15.6 Testing Plan and Log

As tests are performed, the QC Manager shall record on the "Testing Plan and Log" the date the test was conducted, the date the test results were forwarded to the Contracting Officer, remarks and acknowledgement that an accredited or Contracting Officer approved testing laboratory was used. Attach a copy of the updated "Testing Plan and Log" to the last daily Contractor Quality Control Report of each month.

1.15.7 Rework Items List

The QC Manager shall maintain a list of work that does not comply with the Contract, identifying what items need to be reworked, the date the item was originally discovered, the date the item will be corrected by, and the date the item was corrected. There is no requirement to report a rework item that is corrected the same day it is discovered. Attach a copy of the "Rework Items List" to the last daily Contractor Quality Control Report of each month. The Contractor shall be responsible for including on this list items needing rework including those identified by the Contracting Officer.

1.15.8 As-Built Drawings

The QC Manager is required to ensure the as-built drawings, required by Section 01770N "Closeout Procedures," are kept current on a daily basis and marked to show deviations which have been made from the Contract drawings. Ensure each deviation has been identified with the appropriate modifying documentation (e.g. PC No., Modification No., Request for Information No., etc.). The QC Manager shall initial each deviation and each revision. Upon completion of work, the QC Manager shall furnish a certificate attesting to the accuracy of the as-built drawings prior to submission to the Contracting Officer.

1.15.9 Report Forms

The following forms, are acceptable for providing the information required by the paragraph entitled "Documentation." While use of these specific formats are not required, any other format used shall contain the same information:

- a. Contractor Quality Control Report w/ continuation sheet(s).
- b. Contractor Production Report w/ continuation sheet(s).
- c. Preparatory Phase Checklist.
- d. Initial Phase Checklist.
- e. Testing Plan and Log.

f. Rework Items List.

1.16 NOTIFICATION ON NON-COMPLIANCE

The Contracting Officer will notify the Contractor of any detected non-compliance with the foregoing requirements. The Contractor shall take immediate corrective action after receipt of such notice. Such notice, when delivered to the Contractor at the work site, shall be deemed sufficient for the purpose of notification. If the Contractor fails or refuses to comply promptly, the Contracting Officer may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No part of the time lost due to such stop orders shall be made the subject of claim for extension of time for excess costs or damages by the Contractor.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

Not used.

-- End of Section --

SECTION 01500N

TEMPORARY FACILITIES AND CONTROLS

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 C511 (1997) Reduced-Pressure Principle Backflow Prevention Assembly

FOUNDATION FOR CROSS-CONNECTION CONTROL AND HYDRAULIC RESEARCH (FCCCHR)

FCCCHR-CCC Manual of Cross-Connection Control

FCCCHR-USC List of Approved Backflow Prevention Assemblies

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (1999) National Electrical Code

NFPA 241 (1996) Safeguarding Construction, Alteration, and Demolition Operations

1.2 SUBMITTALS

Submit the following in accordance with Section 01330, "Submittal Procedures."

SD-03 Product Data

Backflow preventers

SD-06 Test Reports

Backflow Preventer Tests;

SD-07 Certificates

Backflow Tester Certification;

Backflow Preventers Certificate of Full Approval

1.3 BACKFLOW PREVENTERS CERTIFICATE

Certificate of Full Approval from FCCCHR-USC, 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.

1.3.1 Backflow Prevention Training Certificate

The Contractor shall 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.

1.4 TEMPORARY UTILITIES

Reasonable amounts of electricity and potable water will be made available to the Contractor without charge for the purpose of constructing the Work.

The point at which the Government will deliver such utilities or services and the quantity available is as indicated. The Contractor shall pay all costs incurred in connecting, converting, and transferring the utilities to the work. The Contractor shall make connections, including providing backflow-preventing devices on connections to domestic water lines; and providing transformers; and make disconnections.

1.5 BACKFLOW TESTER CERTIFICATION

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 shall not be affiliated with any company participating in any other phase of this Contract.

1.6 WEATHER PROTECTION

Take necessary precautions to ensure that roof openings and other critical openings in the building are monitored carefully. Take immediate actions required to seal off such openings when rain or other detrimental weather is imminent, and at the end of each workday. Ensure that the openings are completely sealed off to protect materials and equipment in the building from damage.

1.6.1 Building and Site Storm Protection

When a warning of gale force winds is issued, take precautions to minimize danger to persons, and protect the work and nearby Government property. Precautions shall include, but are not limited to, closing openings; removing loose materials, tools and equipment from exposed locations; and removing or securing scaffolding and other temporary work. Close openings in the work when storms of lesser intensity pose a threat to the work or any nearby Government property.

1.7 STATION OPERATION AFFECT ON CONTRACTOR OPERATIONS

1.8 STORAGE AREAS

Contractor shall be responsible for security of his property. The Contract Clause entitled "FAR 52.236-10, Operations and Storage Areas" and the following apply:

1.8.1 Storage Size and Location

The enclosed site available for storage shall be confined to the project area itself. No other laydown area is provided, except as otherwise directed by the ROICC

1.8.2 Storage in Existing Buildings

The Contractor shall be working in an existing building; the storage of material will be allowed within the project area. Provide security fence as required with a lockable gate to secure area. Remove fences and gates at the completion of work.

1.9 TEMPORARY SANITARY FACILITIES

Provide adequate sanitary conveniences of a type approved for the use of persons employed on the work, properly secluded from public observation, and maintained in such a manner as required and approved by the Contracting Officer. Maintain these conveniences at all times without nuisance. Upon completion of the work, remove the conveniences from the premises, leaving the premises clean and free from nuisance. Dispose of sewage through connection to a municipal, district, or station sanitary sewage system. Where such systems are not available, use chemical toilets or comparably effective units, and periodically empty wastes into a municipal, district, or station sanitary sewage system, or remove waste to a commercial facility. Include provisions for pest control and elimination of odors.

PART 2 PRODUCTS

2.1 Backflow Preventers

Reduced pressure principle type conforming to the applicable requirements AWWA C511. Provide backflow preventers complete with 150 pound flanged cast iron, mounted gate valve and strainer, 304 stainless steel or bronze, internal parts. The particular make, model/design, and size of backflow preventers to be installed shall be included in the latest edition of the List of Approved Backflow Prevention Assemblies issued by the FCCCHR-USC and shall be accompanied by a Certificate of Full Approval from FCCCHR-USC.

PART 3 EXECUTION

3.1 TEMPORARY PHYSICAL CONTROLS

3.1.1 Access Controls

3.1.1.1 Temporary Barricades

Contractor shall provide for barricading around all work areas to prevent public access.

3.1.1.2 Fencing

Fencing shall be provided along the construction site at all open excavations and tunnels to control access by unauthorized people. Fencing must be installed to be able to restrain a force of at least 250 pounds against it.

In addition, prior to the start of work, enclose those areas at the construction site which are not within the construction fence with a temporary safety fence, including gates and warning signs, to protect the public from construction activities. The safety fence shall match the base standard color (or bright orange where it protects excavated areas), shall be made of high density polyethylene grid or approved equal, a minimum of 42 inches high, supported and tightly secured to steel posts located on minimum 10 foot centers. Remove the fence from the work site upon completion of the contract.

3.1.1.3 Signs

Place warning signs at the construction area perimeter designating the presence of construction hazards requiring unauthorized persons to keep out. Signs must be placed on all sides of the project, with at least one sign every 300 feet. All points of entry shall have signs designating the construction site as a hard hat area.

3.1.1.4 Traffic Work

All work around/involving roadways, to include roadway excavations and utility crossings, will be conducted in accordance with Manual of Traffic Control Devices. Contractors shall provide and ensure appropriate road closure and detour signs are established as necessary for motor traffic management. All road closures shall be coordinated with the Contracting Officer in advance. Self-illuminated (lighted) barricades shall be provided during hours of darkness. Brightly-colored (orange) vests are required for all personnel working in roadways. Road closures shall require a road closure plan showing the location of signage.

3.2 TEMPORARY WIRING

Provide temporary wiring in accordance with NFPA 241 and NFPA 70, Article 305-6(b), Assured Equipment Grounding Conductor Program. Program shall include frequent inspection of all equipment and apparatus.

3.3 REDUCED PRESSURE BACKFLOW PREVENTERS

Provide an approved reduced pressure backflow prevention assembly at each location where the Contractor taps into the Government potable water supply.

A certified tester(s) shall perform testing of backflow preventer(s) for proper installation and operation and provide subsequent tagging. Backflow preventer tests shall be performed using test equipment, procedures, and

certification forms conforming to those outlined in the latest edition of the Manual of Cross-Connection Control published by the FCCCHR-CCC. Test and tag each reduced pressure backflow preventer upon initial installation (prior to continued water use) and quarterly thereafter. Tag shall contain the following information: make, model, serial number, dates of tests, results, maintenance performed, and signature of tester. Record test results on certification forms conforming to requirements cited earlier in this paragraph.

-- End of Section --

SECTION 01525N

SAFETY REQUIREMENTS

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 in the text by the basic designation only.

The Contractor shall comply with OSHA and Navy safety regulations.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A10.14 (1991) Construction and Demolition Operations - Requirements for Safety Belts, Harnesses, Lanyards and Lifelines for Construction and Demolition Use

ANSI Z359.1 (1992) Safety Requirements for Personal Fall Arrest Systems

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

29 CFR 1910.94 Ventilation

U.S. ARMY CORPS OF ENGINEERS (USACE)

COE EM-385-1-1 (1996) Safety and Health Requirements Manual

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (1999) National Electrical Code

NFPA 241 (1996) Safeguarding Construction, Alteration, and Demolition Operations

1.2 DEFINITIONS

- a. Certified Industrial Hygienist. An industrial hygienist is an individual who is certified by the American Board of Industrial Hygiene.
- b. Certified Safety Professional. A safety manager, safety specialist, or safety engineer that has passed the CSP exam administered by the Board of Certified Safety Professionals.
- c. Competent Person. A competent person is one who is capable of identifying existing and predictable hazards in the surroundings

or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them.

- d. Confined Space. A space which by design has limited openings for entry and exit, unfavorable natural ventilation which could contain or produce dangerous air contaminants, and which is not intended for continuous employee occupancy. Confined spaces include, but are not limited to storage tanks, process vessels, pits, silos, vats, degreasers, reaction vessels, boilers, ventilation and exhaust ducts, sewers, tunnels, underground utility vaults, and pipelines.
- e. First Aid. First aid is any one-time treatment, and any follow-up visit for the purpose of observation, of minor scratches, cuts, burns, splinters, and so forth, which do not ordinarily require medical care, even though provided by a physician or registered professional personnel.
- f. Health and Safety Plan (HASP). The HASP is the Navy equivalent Army term of SHP or SSHP used in COE EM-385-1-1. "USACE" property and equipment specified in COE EM-385-1-1 should be interpreted as Government property and equipment.
- g. Lost Workdays. The number of days (consecutive or not) after, but not including, the day of injury or illness during which the employee would have worked but could not do so; that is, could not perform all or part of his normal assignment during all or any part of the workday or shift; because of the occupational injury or illness.
- h. Medical Treatment. Medical treatment includes treatment administered by a physician or by registered professional personnel under the standing orders of a physician. Medical treatment does not include first aid treatment even through provided by a physician or registered personnel.
- i. Multi-employer work site (MEWS). A multi-employer work site, as defined by OSHA, is one in which many employers occupy the same site. The Navy considers the prime contractor to be the "controlling authority" for all work site safety and health of the subcontractors.
- j. Operating Envelope. There is an "operating envelope" around any crane, and inside the envelope are the operator, riggers, rigging gear between the hook and the load, the load and the crane's supporting structure (ground, rail, etc.).
- k. Qualified Person. One who, by possession of a recognized degree, certificate, or professional standing, or extensive knowledge, training, and experience, has successfully demonstrated his or her ability to solve or resolve problems related to the subject matter, the work or the project.

1. Recordable Occupational Injuries or Illnesses. Any occupational injuries or illnesses which result in:
 - (1) Fatalities, regardless of the time between the injury and death, or the length of the illness; or
 - (2) Lost Workday Cases, other than fatalities, that result in lost workdays, or
 - (3) Non-Fatal Cases without lost workdays which result in transfer to another job or termination of employment, or require medical treatment (other than first aid) or involve: loss of consciousness or restriction of work or motion. This category also includes any diagnosed occupational illnesses which are reported to the employer but are not classified as fatalities or lost workday cases.
- m. Safety Officer. The superintendent or other qualified or competent person who is responsible for the on-site safety required for the project. The contractor quality control person cannot be the safety officer, even though the QC has safety inspection responsibilities as part of the QC duties.
- n. Serious Accidents. Any work-related incident, which results in, a fatality, in-patient hospitalization of three or more employees, or property damage in excess of \$200,000.
- o. Significant Accident. Any contractor accident which involves falls of 4 feet or more, electrical accidents, confined space accidents, diving accidents, equipment accidents, crane accident or fire accidents, which, result in property damage of \$10,000 or more, but less than \$200,000; or when fire department or emergency medical treatment (EMT) assistance is required.
- p. Weight Handling Equipment (WHE) Accident. A WHE accident occurs when any one or more of the six elements in the operating envelope fails to perform correctly during operation, including operation during maintenance or testing resulting in personnel injury or death; material or equipment damage; dropped load; derailment; two-blocking; overload; and collision, including unplanned contact between the load, crane, and/or other objects. A dropped load, derailment, two-blocking, overload and collision are considered accidents even though no material damage or injury occurs. A component failure (e.g., motor burnout, gear tooth failure, bearing failure) is not considered an accident solely due to material or equipment damage unless the component failure results in damage to other components (e.g., dropped boom, dropped load, roll over, etc.).

1.3 SUBMITTALS

Submit the following in accordance with Section 01330, "Submittal Procedures."

SD-07 Certificates

Accident Prevention Plan (APP); G

Activity Hazard Analysis (AHA); G

Health and Safety Plan (HASP); G

Traffic Control Plan; G

SD-11 Closeout Submittals

Reports; G

Submit reports as their incidence occurs, in accordance with the requirements of the paragraph entitled, "Reports."

1.4 QUALITY ASSURANCE

1.4.1 Qualifications

a. Qualifications of Safety Officer:

(1) Ability to manage the on-site contractor safety program through appropriate management controls.

(2) Ability to identify hazards and have the capability to expend resources necessary to abate the hazards.

(3) Must have worked on similar types of projects that are equal to or exceed the scope of the project assigned with the same responsibilities.

(4) Shall, as a minimum, have attended an OSHA training qualification class including at least 10 hours of classroom instruction.

1.4.1.1 Traffic Control Plan

The Contractor shall develop a Traffic Control Plan in accordance with NRLINST 5560.2C, "Temporary and Long Term Road and Parking Closure."Text

1.4.2 Meetings

1.4.2.1 Preconstruction Conference

The safety officer shall attend the preconstruction conference.

1.4.2.2 Meeting on Work Procedures

- a. Meet with Contracting Officer to discuss work procedures and safety precautions required by the APP. Ensure the participation of the contractor's superintendent, the quality control, and the CSP or CIH.

- b. Meet with Contracting Officer to discuss work procedures and safety precautions required by the HASP. Ensure the participation of the contractor's superintendent, the quality control, and the CSP or CIH.

1.4.2.3 Weekly Safety Meetings

Hold weekly at the project site. Attach minutes showing contract title, signatures of attendees and a list of topics discussed to the QC Contractor Quality Control daily report.

1.4.2.4 Work Phase Meetings

The appropriate AHA shall be reviewed and attendance documented by the Contractor at the preparatory, initial, and follow-up phases of quality control inspection.

1.4.2.5 New Employee Indoctrination

New employees will be informed of specific site hazards before they begin work. Documentation of this orientation shall be kept on file at the project site.

1.4.3 Certifications

1.4.3.1 Accident Prevention Plan (APP)

Submit the APP at least 15 calendar days prior to start of work at the job site, following Appendix A of COE EM-385-1-1. Make the APP site specific. Notice To Proceed will be given after Government finds the APP acceptable.

1.4.3.2 Activity Hazard Analysis (AHA)

Submit the AHA for review at least 15 calendar days prior to the start of each phase. Format subsequent AHA as amendments to the APP. In accordance with contract quality control requirements each AHA will be reviewed during an on-site preparatory inspection.

1.4.3.3 Health and Safety Plan (HASP)

Submit the HASP for projects involving the handling of hazardous materials and allow 30 calendar days for review by Naval Environmental Health Center (NEHC) for health hazard review and Naval Facilities Engineering Command, Engineering Field Division (EFD) or Engineering Field Activity (EFA) construction safety manager. The Contracting Officer will act on the HASP only after 30 day NEHC and EFD/EFA safety manager reviews. The Contractor shall have approval, from NRL Safety Office (Code 1240) of the Health and Safety Plan and all safety plan submittal, prior to the commencement of any on site work.

1.4.4 Reports

1.5 ACCIDENT PREVENTION PLAN (APP)

Prepare and submit the APP in accordance with the required and advisory provisions of COE EM-385-1-1 including Appendix A, "Minimum Basic Outline for Preparation of Accident Prevention Plan," and as modified herein. Include the associated AHA and other specific plans, programs and procedures listed on Pages A-3 and A-4 of COE EM-385-1-1, some of which are listed below.

1.5.1 Contents of the Accident Prevention Plan

- a. Name and safety related qualifications of safety officer (including training and any certifications).
- b. Qualifications of competent and of qualified persons.
- c. Identity of the individual who will complete exposure data (hours worked); accident investigations, reports and logs; and immediate notification of accidents to include subcontractors.
- d. Emergency response plan. Conform to COE EM-385-1-1, paragraph 01.E and include a map denoting the route to the nearest emergency care facility with emergency phone numbers. Contractor may be required to demonstrate emergency response.
- e. Confined Space Entry Plan. Identify the qualified person's name and qualifications, training, and experience. Delineate the qualified person's authority to direct work stoppage in the event of hazardous conditions. Include procedure for rescue by contractor personnel and the coordination with emergency responders. (If there is no confined space work, include a statement that no confined space work exists and none will be created.)
- f. Hazardous Material Use. Provisions to deal with hazardous materials, pursuant to the Contract Clause "FAR 52.223-3, Hazardous Material Identification and Material Safety Data." And the following:
 - (1) Inventory of hazardous materials to be introduced to the site with estimated quantities.
 - (2) Plan for protecting personnel and property during the transport, storage and use of the materials.
 - (3) Emergency procedures for spill response and disposal, including a site map with approximate quantities on site at any given time. The site map will be attached to the inventory, showing where the hazardous substances are stored.
 - (4) Material Safety Data Sheets for inventoried materials not required in other section of this specification.
 - (5) Labeling system to identify contents on all containers on-site.

- (6) Plan for communicating high health hazards to employees and adjacent occupants.
- g. Hazardous Energy Control Plan. For hazardous energy sources, comply with COE EM-385-1-1, paragraph 12.A.07.
- h. Alcohol and Drug Abuse Plan
- (1) Describe plan for random checks and testing with pre-employment screening in accordance with the DFAR Clause subpart 252.223-7004, "Drug Free Work Force."
- (2) Description of the on-site prevention program
- i. Fall Protection and Prevention (FP&P) Plan. The plan shall be site specific and address all fall hazards in the work place. It shall address how to protect and prevent workers from falling to lower levels when they are exposed to fall hazards above 6 feet. A qualified person shall prepare the plan. The plan shall include fall protection and prevention systems, equipment and methods employed, responsibilities, rescue and escape equipment and operations, training requirements, and monitoring methods.
- j. Silica Exposure Reduction. The plan shall include specific procedures to prevent employee silica inhalation exposures.
- k. Lead Abatement Plan. The safety and health aspects of lead-based paint removal, prepared in accordance with Section 13283N, "Removal and Disposal of Lead Containing Paint".
- l. Asbestos Abatement Plan. The safety and health aspects prepared in accordance with Section 13281N, "Engineering Control of Asbestos Containing Materials"
- m. Site Demolition Plan. The safety and health aspects prepared in accordance with Section 02220N, "Site Demolition" and referenced sources.
- n. Excavation Plan. The safety and health aspects prepared in accordance with Section 02315N, "Excavation and Fill.
- o. Training Records and Requirements. List of mandatory training and certifications which are applicable to this project (e.g. explosive actuated tools, confined space entry, fall protection, crane operation, vehicle operator, forklift operators, personal protective equipment); list of requirements for periodic retraining/certification; outline requirements for supervisory and employee safety meetings.
- p. Severe Weather Plan. Procedures of ceasing on-site operations during lightning or upon reaching maximum allowed wind velocities.
- q. Emergency Lighting and Power Systems Plan (e.g. periodic testing

of batteries for emergency lighting.)

1.5.2 Hazardous Material Use

Each hazardous material must receive approval prior to bringing onto the job site or prior to any other use in connection with this contract. Allow a minimum of 10 working days for processing of the request for use of a hazardous material. Any work or storage involving hazardous chemicals or materials must be done in a manner that will not expose government employees to any unsafe or unhealthful conditions. Adequate protective measures must be taken to prevent government employees from being exposed to any hazardous condition that could result from the work or storage. Approval by the Contracting Officer of protective measures and storage area is required prior to the start of the work.

1.6 ACTIVITY HAZARD ANALYSIS (AHA)

Prepare for each phase of the work. As a minimum, define activity being performed, sequence of work, specific hazards anticipated, control measures to eliminate or reduce each hazard to acceptable levels, training requirements for all involved, and the competent person in charge of that phase of work. For work with fall hazards, including fall hazards associated with scaffold erection and removal, identify the appropriate fall arrest systems. For work with materials handling equipment, address safeguarding measures related to materials handling equipment. For work requiring excavations, include excavation safeguarding requirements. The appropriate AHA shall be reviewed and attendance documented by the Contractor at the preparatory, initial, and follow-up phases of quality control inspection. The Activity Hazardous Analysis shall be site specific. The Contractor shall submit copies of training certificates as evidence of employees attending safety training.

1.7 DRUG PREVENTION PROGRAM

Conduct a proactive drug and alcohol use prevention program for all workers, prime and subcontractor, on the site. Ensure that no employees either use illegal drugs or consume alcohol during work hours. Ensure there are no employees under the influence of drugs or alcohol during work hours. After accidents, collect blood, urine or saliva specimens and test injured employee's influence. A copy of the test shall be made available to the Contracting Officer upon request.

1.8 FALL HAZARD PROTECTION AND PREVENTION PROGRAM

1.8.1 Scaffolds

Delineate the fall protection requirements necessary during the erection and dismantling operation of scaffolds used on the project in the Fall Protection and Prevention (FP&P) plan and activity hazard analysis for the phase of work.

1.8.2 Training

Institute a fall protection training program. As part of the Fall Hazard

Protection and Prevention Program, Contractor shall provide training for each employee who might be exposed to fall hazards.

1.9 DUTIES OF THE SAFETY OFFICER

- a. Ensure construction hazards are identified and corrected.
- b. Maintain applicable safety reference material on the job site.
- c. Maintain a log of safety inspections performed.
- d. Attend the pre-construction conference as required.
- e. Identify hazardous conditions and take corrective action. Failure to do so will result in a dismissal from the site, with a work stoppage pending approval of suitable replacement personnel.

1.10 DISPLAY OF SAFETY INFORMATION

Display the following information in clear view of the on-site construction personnel:

- a. Map denoting the route to the nearest emergency care facility with emergency phone numbers.
- b. AHA
- c. Confined space entry permit.

1.11 SITE SAFETY REFERENCE MATERIALS

Maintain safety-related references applicable to the project, including those listed in the article "References." Maintain applicable equipment manufacturers' manuals.

1.12 HIGH HAZARD WORK AND LONG DURATION

Work under this contract is potentially hazardous. Pursuant to contract clause "FAR 52.236-13, Accident Prevention, Alternate I," submit in writing additional proposals for effecting accident prevention under hazardous conditions. Meet in conference with Contracting Officer to discuss and develop mutual understanding relative to the administration of the overall safety program.

1.13 EMERGENCY MEDICAL TREATMENT

Contractors will arrange for their own emergency medical treatment. Government has no responsibility to provide emergency medical treatment. However, if emergency medical care is rendered by Navy medical services, charges may be billed to Contractor at prevailing rates established in BUMED Instruction 6320.4 series. Reimbursement shall be made by Contractor to Naval Regional Medical Center Collection Agent upon receipt of monthly statement.

1.14 REPORTS

1.14.1 Accident Reports

- a. For recordable occupational injuries and illnesses, the Prime Contractor shall conduct an accident investigation to establish the root cause(s) of the accident, complete the Navy Contractor Significant Incident Report (CSIR) form and provide to the Contracting Officer within 5 calendar days of the accident. The Contracting Officer will provide a copy of the CSIR form.
- b. For a weight handling equipment accident the Prime Contractor shall conduct an accident investigation to establish the root cause(s) of the accident, complete the WHE Accident Report form and provide to the Contracting Officer within 30 calendar days of the accident. The Contracting Officer will provide a blank copy of the WHE accident report form.

1.14.2 Notification

Notify the Contracting Officer as soon as practical, but not later than four hours, of any accident meeting the definition of Recordable Occupational Injuries or Illnesses or Significant Accidents. Information shall include contractor name; contract title; type of contract; name of activity, installation or location where accident occurred; date and time of accident; names of personnel injured; extent of property damage, if any; and brief description of accident (to include type of construction equipment used, PPE used, etc.).

1.14.3 Monthly Exposure Report

Monthly exposure reporting, to the Contracting Officer is required to be attached to the monthly billing request. This report is a compilation of employee-hours worked each month for all site workers, both prime and subcontractor.

1.14.4 OSHA Citations and Violations

Furnish the Contracting Officer with a copy of each OSHA citation, OSHA report and contractor response. Correct violations and citations promptly and provide written corrective actions to the Contracting Officer.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 CONSTRUCTION

Comply with COE EM-385-1-1, NFPA 241, the accident prevention plan, the activity hazard analysis and other related submittals and activity fire and safety regulations.

3.1.1 Hazardous Material Exclusions

Notwithstanding any other hazardous material used in this contract, radioactive materials or instruments capable of producing ionizing/non-ionizing radiation as well as materials which contain asbestos, mercury or polychlorinated biphenyls, di-isocyanates, lead-based paint are prohibited. Exceptions to the use of any of the above excluded materials may be considered by Contracting Officer upon written request by Contractor.

3.1.2 Unforeseen Hazardous Material

The design should have identified materials such as PCB, lead paint, and friable and nonfriable asbestos. If additional material, not indicated, that may be hazardous to human health upon disturbance during construction operations is encountered, stop that portion of work and notify the Contracting Officer immediately. Within 14 calendar days the Government will determine if the material is hazardous. If material is not hazardous or poses no danger, the Government will direct the Contractor to proceed without change. If material is hazardous and handling of the material is necessary to accomplish the work, the Government will issue a modification pursuant to "FAR 52.243-4, Changes" and "FAR 52.236-2, Differing Site Conditions."

3.2 PRE-OUTAGE COORDINATION MEETING

Contractors are required to apply for utility outages a minimum of 15 days in advance. As a minimum, the request should include the location of the outage, utilities being effected, duration of outage and any necessary sketches. Special requirements for electrical outage requests are contained elsewhere in this specification section. Once approved and prior to beginning work on the utility system requiring shut down, the Contractor shall attend a pre-outage coordination meeting with the ROICC and the Station Utilities Department to review the scope of work and the lock out/tag out procedures for worker protection. No work will be performed on energized electrical equipment unless proven impassable. Working equipment "hot" must be considered the last option. All outage requests must be made at least 15 days in advance of the requested closure.

3.3 PERSONNEL PROTECTION

3.3.1 Hazardous Noise

Provide hazardous noise signs, and hearing protection, wherever equipment and work procedures produce sound-pressure levels greater than 85 dBA steady state or 140 dBA impulse, regardless of the duration of the exposure.

3.3.2 Fall Protection

Enforce use of the fall protection device designated for each specific work activity in the FP&P plan and/or AHA all times when an employee is on a surface 6 feet or more above lower levels. Personal fall arrest systems are required when working from an articulating or extendible boom, scissor lifts, swing stages, or suspended platform. Fall protection must comply

with ANSI A10.14.

3.3.2.1 Personal Fall Arrest Device

Personal fall arrest device equipment, systems, subsystems, and components shall meet ANSI Z359.1, "Safety Requirements for Personal Fall Arrest Systems". Only a full-body harness with a shock absorbing lanyard or self-retracting lanyard is an acceptable personal fall arrest device. Body belts may only be used as a positioning device system such as steel reinforcing assembly and in conjunction with another fall arrest system. Harnesses shall have a fall arrest attachment, which is a connector, affixed to the body support (usually a D-ring) and specifically designated for attachment to the rest of the system. Only double locking snap hooks and carabiners shall be used. Webbing, straps, and ropes shall be made of synthetic fiber.

3.4 SCAFFOLDING

Employees shall be provided with a safe means of access to the work area on the scaffold. Climbing of any scaffold braces or supports not specifically designed for access is prohibited. Stair towers or ladders built into scaffold systems in accordance with USACE EM 385-1-1 Appendix J are required for work platforms greater than 20 feet in height. Contractor shall ensure that employees that are qualified perform scaffold erection. Do not use scaffold without the capability of supporting at least four times the maximum intended load or without appropriate fall protection as delineated in the accepted fall protection plan. Minimum platform size shall be based on the platform not being greater in height than three times the dimension of the smallest width dimension for rolling scaffold. Some Baker type scaffolding has been found not to meet these requirements. Stationary scaffolds must be attached to structural building components to safeguard against tipping forward or backward. Special care shall be given to ensure scaffold systems are not overloaded. Outrigger brackets used to extend scaffold platforms on self supported scaffold systems for the storage of material is prohibited. The first tie-in shall be at the height equal to 4 times the width of the smallest dimension of the scaffold base.

3.5 EQUIPMENT

3.5.1 Material Handling Equipment

- a. Material handling equipment such as forklifts shall not be modified with work platform attachments for supporting employees unless specifically delineated in the manufacturer's printed operating instructions.
- b. The use of hooks on equipment for lifting of material must be in accordance with manufacturers printed instructions.

3.5.2 Lock-out/Tag-out

The Contractor shall comply with the Lock-out/Tag-out and energy isolation requirements of 29 CFR 1926, 147.

3.6 Excavations

The competent person for excavation performed as a result of contract work shall be on-site when work is being performed in excavation, and shall inspect excavations prior to entry by workers. The competent person must evaluate for all hazards, including atmospheric, that may be associated with the work, and shall have the resources necessary to correct hazards promptly. Prior to digging the appropriate digging permit must be obtained. All underground utilities in the work area must be positively identified by a utility locating service and coordinated with Station Utility Departments. The Contractor must physically verify underground utility locations by hand digging using wood or fiberglass handled tools when any adjacent construction work is expected to come within three feet of the underground system. If construction is parallel to an existing utility the utility shall be exposed by hand digging every 100 feet if parallel within 5 feet of the excavation. Trench and shoring systems must be identified in the accepted safety plan and activity hazard analysis. Extreme care must be used when excavating near direct burial electric underground cables. Trenching machines with digging chain drives shall be operated only when the spotters/laborers are in plain view of the operator. Operator and spotters/laborers shall be provided training on the hazards of the digging chain drives with emphasis on the distance that needs to be maintained when the digging chain is operating. Documentation of the training shall be kept on file in the project site office or trailer.

3.7 ELECTRICAL

3.7.1 Conduct of Electrical Work

Underground electrical spaces must be certified safe for entry before entering to conduct work. Cable intended to be cut must be positively identified and de-energized prior to performing each cut. Positive cable identification must be made prior to submitting any outage request for electrical systems. Arrangements are to be coordinated with the Contracting Officer and Station Utilities for identification. The Contracting Officer will not accept an outage request until the Contractor satisfactorily documents that the circuits have been clearly identified. Perform all high voltage cutting remotely. When racking in or live switching of circuit breakers, no additional person other than the switch operator will be allowed in the space during the actual operation. Plan so that work near energized parts is minimized to the fullest extent possible. Use of electrical outages clear of any energized electrical sources is the preferred method. When working in energized substations, only qualified electrical workers shall be permitted to enter. When work requires Contractor to work near energized circuits as defined by the NFPA 70, high voltage personnel must use personal protective equipment that includes, as a minimum, electrical hard hat, safety shoes, insulating gloves with leather protective sleeves, fire retarding shirts, coveralls, face shields, and safety glasses. Insulating blankets, hearing protection, and switching suits may be required, depending on the specific job and as delineated in the Contractor AHA.

3.7.2 Portable Extension Cords

Portable extension cords shall be sized in accordance with manufacturer ratings for the tool to be powered.

3.8 CRYSTALLINE SILICA

Grinding, abrasive blasting, and foundry operations of construction materials containing crystalline silica, shall comply with OSHA regulations, such as 29 CFR 1910.94, and COE EM-385-1-1, (Appendix C). The Contractor shall develop and implement effective exposure control and elimination procedures to include dust control systems, engineering controls, and establishment of work area boundaries, as well as medical surveillance, training, air monitoring, and personal protective equipment.

3.9 HOUSEKEEPING

3.9.1 Clean-up

All debris in work areas shall be cleaned up daily or more frequently as necessary. Construction debris may be temporarily located in an approved location, however garbage accumulation must be removed each day.

3.9.2 Dust Control

In addition to the dust control measures required elsewhere in the contract documents dry cutting of brick or masonry shall be prohibited. Wet cutting must address control of water run off.

3.10 ACCIDENT SCENE PRESERVATION

For serious accidents, and accidents involving weight handling equipment, ensure the accident site is secured and evidence is protected remaining undisturbed until released by the Contracting Officer.

3.11 FIELD QUALITY CONTROL

3.11.1 Inspections

Include safety inspection as a part of the daily Quality Control inspections required in Section 01450N, "Quality Control".

3.12 FLAMMABLE AND COMBUSTIBLE LIQUID HANDLING AND STORAGE

3.12.1 Safety Gas Containers

Handling of flammable and combustible liquids shall be in safety containers with flame arresters, with not more than 5 gallons capacity, having a spring-closing lid and spout cover and designed to safely relieve internal pressures under fire exposures. Flammable and combustible Liquids shall be stored in separate NFPA approved storage cabinets 50 feet away from any sources of ignition with suitable NO SMOKING OR OPEN FLAME signs posted in all such areas.

-- End of Section --

SECTION 01572N

CONSTRUCTION WASTE MANAGEMENT

PART 1 GENERAL

1.1 DEFINITIONS

1.1.1 Construction and Demolition Waste

Solid wastes such as building materials, packaging and rubble resulting from construction, remodeling, demolition and repair of facilities, paving and infrastructure. The Contractor shall track the quantity and type of materials recycled. Documentation to this effect shall be forwarded to the Safety Office at NRL.

1.1.2 Recyclable Materials

Products and materials that can be recovered and remanufactured into a new product. Recyclable materials include, but are not limited to, the following:

- a. Metals (ferrous and non-ferrous), including banding, metal studs, ductwork, piping
- b. Asphaltic concrete paving
- c. Portland cement concrete
- d. Land clearing debris including trees and plant materials
- e. Native rock and granular fill
- f. Gypsum products
- g. Paper and cardboard
- h. Wood products, including structural, finish, crates and pallets
- i. Brick and masonry
- j. Carpet and padding
- k. Plastics
- l. Copper wiring
- m. Mechanical and electrical products and equipment

1.1.3 Recycling Facility

A business that specializes in collecting, handling, processing, distributing, or remanufacturing waste materials generated by demolition and new construction projects, into products or materials that can be used for this project or by others.

1.1.4 Salvage and Reuse

Existing usable product or material that can be saved and reused in some manner on the project site. Materials for reuse must be approved by the Contracting Officer. Materials that can be salvaged and reused must comply with the applicable technical specifications and include, but are not limited to, the following:

- a. Dimensional lumber and other wood products
- b. Structural steel
- c. Soil
- d. Masonry products
- e. Plants

1.1.5 Salvage for Resale

Existing usable product or material that can be saved and removed intact (as is) from the project site to another site for resale to others without remanufacturing.

1.2 SUBMITTALS

Submit the following in accordance with Section 01330, "Submittal Procedures."

SD-01 Preconstruction Submittals

Construction Waste Management Plan; G

1.2.1 Submittal to ROICC

Submit two copies of the Construction Waste Management Plan to the ROICC in accordance with Section 01330, "Submittal Procedures." The ROICC reviews the plan for completeness and acceptability and approves the submittal.

1.3 CONSTRUCTION WASTE MANAGEMENT

1.3.1 General Intent

The Contractor shall use all means available to divert to the greatest extent practical and economically feasible, construction and demolition waste will be going to landfills and incinerators. This information is essential for accurate reporting of construction and demolition debris by the Navy.

1.3.2 Construction Waste Management Operations

Take a pro-active, responsible role in management of construction waste and require all subcontractors, vendors, and suppliers to participate in the effort. Establish a construction waste management program that includes the following categories:

- a. Minimizing Packaging Waste
- b. Salvage and reuse
- c. Salvage for resale or donation
- d. Recycling
- e. Disposal

A diligent effort shall be made to salvage and reuse products and materials. Waste materials that cannot be salvaged and reused, and have value as being recyclable, shall be recycled. Only materials that can not be economically salvaged or recycled shall be transported to a landfill or incinerator. The Contractor shall be responsible for implementation of any special programs involving rebates or similar incentives related to recycling construction waste for this project. Revenues or other savings obtained for recycling or returns shall accrue to the Contractor, except for revenues generated from Base recycling activities.

1.3.3 Construction Waste Management Plan

Perform a waste analysis to determine the types and quantity of construction waste anticipated and identify salvage for resale, salvage and reuse, recycling and disposal options available. Within 30 days after contract award and prior to performing any demolition work, submit a Construction Waste Management Plan for review and approval. The Construction Waste Management Plan shall include the following:

- a. Estimated waste analysis. Projected total quantities of materials generated. Note that this is the TOTAL GENERATED, including all materials, whether recycled, disposed, or salvaged.
- b. Estimated cost of disposing of all trash and waste materials as if there would be no salvage or recycling on this project. The cost of disposal includes transportation, container rental, labor, and any other costs incurred as a result of disposal operations.
- c. Name, address and phone number for each landfill, incinerator, and recycling facility to be utilized.
- d. A list of materials that will be salvaged for resale, salvaged and reused, and recycled.
- e. Anticipated net cost savings determined by subtracting the cost of handling and transporting from the following:

1. Savings due to reuse of demolished materials.
2. Revenue from the sale of salvaged and recycled materials.
3. Landfill or incinerator tipping fees saved due to diversion of materials to recycling.

1.3.4 Construction Waste Management Plan Form

By filling out all fields of the Construction Waste Management Plan form (a sample form is located at the end of this Guide Specification), the contractor will be in compliance with the requirements of subpart CONSTRUCTION WASTE MANAGEMENT. Note that there are additional requirements in Part 3, EXECUTION.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.1 PROGRAM IMPLEMENTATION AND MONITORING

Implement and maintain, for the duration of the project, the construction waste management program. Establish a method of monitoring and documenting the program, and submit a periodic report with each application for payment that includes the following:

- a. Amount (by weight) and type of waste materials disposed of in a landfill or incinerator, the tip fee per ton, and the total cost of disposal including transportation costs, container rental costs, etc.
- b. Amount (by weight) and type of materials salvaged for sale, salvaged for reuse, and recycled. Provide destination, means of transportation, cost of transportation and handling, tipping fee savings and revenue generated for each material.
- c. Cost savings due to salvaging, reusing, and recycling materials.

3.1.1 Hazardous Materials/Hazardous Wastes

If any non-acceptable materials such as hazardous materials or hazardous wastes are encountered, notify the Contracting Officer and proceed in accordance with the paragraph on "Unforeseen Hazardous Materials" in Section 01525N.

3.2 SALVAGE AND REUSE

Encourage the practice of efficient waste management when, sizing, cutting, and installing products and materials.

3.3 SEPARATION OF RECYCLABLE WASTE MATERIALS

Provide the necessary containers and bins, to facilitate the waste management program, that are clearly and appropriately marked. Prevent contamination of recyclable materials from incompatible products and materials. Separate construction waste at the project site by one of the following methods:

- a. Source Separated Method: Waste products and materials, that are recyclable, are separated from trash and sorted into appropriately marked separate containers and then transported to the respective recycling facility for further processing. Trash is transported to a landfill or incinerator.
- b. Co-Mingled Method: All construction waste is placed into a single container and then transported to a recycling facility where the recyclable materials are sorted and processed and the remaining trash is transported to a landfill or incinerator.
- c. Other methods proposed by the Contractor and approved by the Contracting Officer.

3.4 SAMPLE CONSTRUCTION WASTE MANAGEMENT FORM

A sample Construction Waste Management Form can be found at the Unified Facilities Guide Specifications web site <http://criteria.navfac.navy.mil/criteria/GuideSpecs/home.htm> or from the Construction Criteria Base web site: www.ccb.org

-- End of Section --

SECTION 01575N

TEMPORARY ENVIRONMENTAL CONTROLS

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 in the text by the basic designation only.

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

29 CFR 1910	Occupational Safety and Health Standards
29 CFR 1910.1200	Hazard Communication
40 CFR 112	Oil Pollution Prevention
40 CFR 122.26	EPA National Pollutant Discharge Elimination System Permit Regulations
40 CFR 241	Guidelines for Disposal of Solid Waste
40 CFR 243	Guidelines for the Storage and Collection of Residential, Commercial, and Institutional Solid Waste
40 CFR 258	Subtitle D Landfill Requirements
40 CFR 261	Identification and Listing of Hazardous Waste
40 CFR 262	Generators of Hazardous Waste
40 CFR 263	Transporters of Hazardous Waste
40 CFR 264	Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities
40 CFR 265	Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities
40 CFR 266	Management of Specific Hazardous Wastes and Specific Types of Hazardous Waste Management Facilities
40 CFR 268	Land Disposal Restrictions

40 CFR 279	Used Oil Regulations
40 CFR 300	National Oil and Hazardous Substances Pollution Contingency Plan
40 CFR 355	Emergency Planning and Notification
40 CFR 372-SUBPART D	EPA Toxic Chemical Release Reporting Regulations
49 CFR 173	Shipments and Packagings
49 CFR 178	Specifications for Packagings

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA 832-R-92-005	Storm Water Management for Construction Activities
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1.2 DEFINITIONS

1.2.1 Sediment

Soil and other debris that have eroded and have been transported by runoff water or wind.

1.2.2 Solid Waste

Garbage, refuse, debris, sludge, or other discharged material (except hazardous waste as defined in paragraph entitled "Hazardous Waste" or hazardous debris as defined in paragraph entitled "Hazardous Debris"), including solid, liquid, semisolid, or contained gaseous materials resulting from domestic, industrial, commercial, mining, or agricultural operations. Material not regulated as solid waste are: nuclear source or byproduct materials regulated under the Federal Atomic Energy Act of 1954 as amended; suspended or dissolved materials in domestic sewage effluent or irrigation return flows, or other regulated point source discharges; regulated air emissions; and fluids or wastes associated with natural gas or crude oil exploration or production.

- a. Green waste: The vegetative matter from landscaping, land clearing and grubbing, including, but not limited to, grass, bushes, scrubs, small trees and saplings, tree stumps and plant roots. Marketable trees, grasses and plants that are indicated to remain, be re-located, or be re-used are not included.
- b. Surplus soil: Existing soil that is in excess of what is required for this work, including aggregates intended, but not used, for on-site mixing of concrete, mortars and paving. Contaminated soil meeting the definition of hazardous material or hazardous waste is not included.
- c. Inert construction and demolition debris: Broken or removed concrete, masonry, and rock asphalt paving; ceramics; roofing

paper and shingles. Inert materials may be re-inforced with or contain ferrous wire, rods, accessories and weldments, if permitted by the landfill regulations.

- d. Wood: Dimension and non-dimension lumber, plywood, chipboard, hardboard. Treated and/or painted wood that meets the definition of lead contaminated or lead based contaminated paint is not included.
- e. Scrap metal: Scrap and excess ferrous and non-ferrous metals such as re-inforcing steel, structural shapes, pipe and wire that are recovered or collected and disposed of as scrap. Scrap metal meeting the definition of hazardous material or hazardous waste is not included.
- f. Paint cans: Metal cans that are empty of paints, solvents, thinners and adhesives. If permitted by the paint can label, a thin dry film may remain in the can.
- g. Recyclables: Materials, equipment and assemblies such as doors, windows, door and window frames, plumbing fixtures, glazing and mirrors that are recovered and sold as recyclable. Metal meeting the definition of lead contaminated or lead based paint contaminated may not be included as recyclable if sold to a scrap metal company. Paint cans may not be included as recyclable if sold to a scrap metal company.

1.2.3 Debris

Non-hazardous solid material generated during the construction, demolition, or renovation of a structure which exceeds 2.5 inch particle size that is: a manufactured object; plant or animal matter; or natural geologic material (e.g. cobbles and boulders). A mixture of debris and other material such as soil or sludge is also subject to regulation as debris if the mixture is comprised primarily of debris by volume, based on visual inspection.

1.2.4 Hazardous Debris

As defined in paragraph entitled "Debris" of this section, debris that contains listed hazardous waste (either on the debris surface, or in its interstices, such as pore structure) per 40 CFR 261; or debris that exhibits a characteristic of hazardous waste per 40 CFR 261.

1.2.5 Chemical Wastes

This includes salts, acids, alkalies, herbicides, pesticides, and organic chemicals.

1.2.6 Garbage

Refuse and scraps resulting from preparation, cooking, dispensing, and consumption of food.

1.2.7 Hazardous Waste

Hazardous waste as defined in 40 CFR 261 or as defined by applicable State and local regulations.

1.2.8 Oily Waste

Petroleum products and bituminous materials.

1.2.9 Regulated Waste

Those solid waste that have specific additional Federal, state, or local controls for handling, storage, or disposal.

1.2.10 Class I Ozone Depleting Substance (ODS)

Class I ODS is defined in Section 602(a) of The Clean Air Act and includes the following chemicals:

chlorofluorocarbon-11 (CFC-11)	chlorofluorocarbon-213 (CFC-213)
chlorofluorocarbon-12 (CFC-12)	chlorofluorocarbon-214 (CFC-214)
chlorofluorocarbon-13 (CFC-13)	chlorofluorocarbon-215 (CFC-215)
chlorofluorocarbon-111 (CFC-111)	chlorofluorocarbon-216 (CFC-216)
chlorofluorocarbon-112 (CFC-112)	chlorofluorocarbon-217 (CFC-217)
chlorofluorocarbon-113 (CFC-113)	halon-1211
chlorofluorocarbon-114 (CFC-114)	halon-1301
chlorofluorocarbon-115 (CFC-115)	halon-2402
chlorofluorocarbon-211 (CFC-211)	carbon tetrachloride
chlorofluorocarbon-212 (CFC-212)	methyl chloroform

1.2.11 Hazardous Materials

Any material that is regulated as a hazardous material in accordance with 49 CFR 173, requires a Material Safety Data Sheet (MSDS) in accordance with 29 CFR 1910.1200, or which during end use, treatment, handling, storage, transportation or disposal meets or has components which meet or have the potential to meet the definition of a Hazardous Waste in accordance with 40 CFR 261. Throughout this specification, hazardous material includes hazardous chemicals.

1.3 SUBMITTALS

Submit the following in accordance with Section 01330, "Submittal Procedures."

SD-01 Preconstruction Submittals

Environmental protection plan; G

SD-06 Test Reports

Laboratory analysis

TCLP results; G

SD-11 Closeout Submittals

Some of the records listed below are also required as part of other submittals. For the "Records" submittal, maintain on-site a separate three-ring Environmental Records binder and submit at the completion of the project. Make separate parts to the binder corresponding to each of the applicable sub items listed below.

Preconstruction survey

Solid waste disposal permit

Waste determination documentation

Disposal documentation for hazardous and regulated waste; G

Contractor 40 CFR employee training records

Regulatory notification

Erosion and sediment control inspection reports; G

Solid waste disposal report; G

Contractor Hazardous Material Inventory Log; G

1.4 LABORATORY ANALYSIS

Submit a copy of a laboratory analysis of solid waste and debris with the potential of becoming classified as a hazardous waste (i.e., abrasive/sand blasting debris, etc.). Waste stream determinations are required at the point of generation and must sufficiently document whether the waste will be a solid waste, hazardous waste, or Resource Conservation and Recovery Act (RCRA) exempt waste. Determinations must use EPA approved methods and provide written rationale for whether the waste is classified as hazardous or non-hazardous. The Contractor shall bear the cost of the waste stream determinations, and the Contracting Officer reserves the right to request waste stream determinations on questionable waste streams.

1.5 REPORTS

1.5.1 Preconstruction Survey

Perform a preconstruction survey of the project site with the Contracting Officer, and take photographs, with permission from the ROICC, showing existing environmental conditions in and adjacent to the site. Submit a report for the record.

1.5.2 Solid Waste Disposal Permit

Submit one copy of a State permit or license showing such agency's approval of the disposal plan before transporting wastes off Government property.

1.5.3 Waste Determination Documentation

The Contractor shall complete a Waste Determination form (provided at the pre-construction conference) for all contractor derived wastes to be generated. The waste determination must be based upon either a constituent listing from the manufacturer used in conjunction with consideration of the process by which the waste was generated, EPA approved analytical data, or laboratory analysis (Material Safety Data Sheets (MSDS) by themselves are not adequate). All support documentation must be attached to the Waste Determination form. As a minimum, a Waste Determination form must be provided for the following wastes (this listing is not all inclusive): oil and latex based painting and caulking products, solvents, adhesives, aerosols, petroleum products, and all containers of the original materials.

1.5.4 Disposal Documentation for Hazardous and Regulated Waste

Submit a copy of the applicable EPA and State permit(s), manifest(s), or license(s) for transportation, treatment, storage, and disposal of hazardous and regulated waste by permitted facilities.

1.5.5 Contractor 40 CFR Employee Training Records

Prepare and maintain employee training records throughout the term of the contract meeting applicable 40 CFR requirements. Submit these training records to the Contracting Officer at the conclusion of the project, unless otherwise directed.

1.5.6 Regulatory Notification

The Contractor is responsible for all regulatory notification requirements in accordance with Federal, State and local regulations. The Contractor shall forward copies to the Contracting Officer prior to commencement of work activities. Typically, regulatory notifications must be provided for the following (this listing is not all inclusive): demolition, renovation, NPDES defined site work, remediation of controlled substances (asbestos, hazardous waste, lead paint).

1.5.7 Erosion and Sediment Control Inspection Reports

Submit "Erosion and Sediment Control Inspection Reports" (form provided at the pre-construction conference) to the Contracting Officer once every 7 calendar days and within 24 hours of a storm event that produces 0.5 inch or more of rain.

1.5.8 Solid Waste Disposal Report

Monthly the Contractor shall submit a solid waste disposal report to the Contracting Officer. For each waste, the report shall state the classification (using the definitions provided in this section), amount, location, and name of the business receiving the solid waste. The Contractor shall include copies of the waste handling facilities' weight tickets, receipts, bills of sale, and other sales documentation. In lieu of sales documentation, the Contractor may submit a statement indicating the disposal location for the solid waste which is signed by an officer of the Contractor firm authorized to legally obligate or bind the firm. The

sales documentation or Contractor certification shall include the receiver's tax identification number and business, EPA or State registration number, along with the receiver's delivery and business addresses and telephone numbers. For each solid waste retained by the Contractor for his own use, the Contractor shall submit on the solid waste disposal report the information previously described in this paragraph. Prices paid or received shall not be reported to the Contracting Officer unless required by other provisions or specifications of this Contract or public law.

1.5.9 Toxic Characteristic Leaching Procedure (TCLP)

Submit TCLP results test to determine the disposition of materials containing lead based paint.

1.6 CLASS I ODS PROHIBITION

Class I ODS as defined and identified herein shall not be used in the performance of this contract, nor be provided as part of the equipment. This prohibition shall be considered to prevail over any other provision, specification, drawing, or referenced documents. The Government shall be responsible for reclaiming all Class I DDS refrigerants from equipment prior to Contractor demolition.

1.7 ENVIRONMENTAL PROTECTION REQUIREMENTS

Provide and maintain, during the life of the contract, environmental protection as defined. Plan for and provide environmental protective measures to control pollution that develops during normal construction practice. Plan for and provide environmental protective measures required to correct conditions that develop during the construction of permanent or temporary environmental features associated with the project. Comply with Federal, State, and local regulations pertaining to the environment, including water, air, solid waste, hazardous waste and substances, oily substances, and noise pollution.

Environmental Brief: Attend an environmental brief to be included in the preconstruction meeting. Provide the following information: types, quantities, and use of hazardous materials that will be brought onto the activity; types and quantities of wastes/wastewater that may be generated during the contract.

1.7.1 Facility Hazardous Waste Generator Status

Naval Research Laboratory is designated as a Small Quantity Generator. All work conducted within the boundaries of this activity must meet the regulatory requirements of this generator designation. The Contractor shall comply with all provisions of Federal, State and local regulatory requirements applicable to this generator status regarding training and storage, handling, and disposal of all construction derived wastes.

1.7.2 Licenses and Permits

Obtain licenses and permits pursuant to the "Permits and Responsibilities"

FAR Clause except for the following permits which may be obtained by the Contracting Officer:

- a. District of Columbia Government, Department of Health, Environmental Health Administration, Watershed Protection Branch: "Soil Erosion & Sediment Control".
- b. District of Columbia Government, Department of Health, Environmental Health Administration, Watershed Protection Branch: "Stormwater Management Exemption".

For permits obtained by the Contracting Officer, whether or not required by the permit, the Contractor is responsible to perform quality control inspections of the work in progress, and to submit notifications and certifications to the applicable regulatory agency, via the Contracting Officer, that the work conforms to the contract and permit requirements. The inspections and certifications shall be provided through the services of a Professional Engineer, registered in the State where the work is being performed. As a part of the quality control plan, which is required to be submitted for approval by the quality control section, provide a sub item containing the name, P.E. registration number, address, and telephone number of the professional engineer(s) who will be performing the inspections and certifications for each permit listed above.

1.7.3 Contractor Liabilities for Environmental Protection

The Contractor is advised that this project and the station are subject to Federal, State, and local regulatory agency inspections to review compliance with environmental laws and regulations. The Contractor shall fully cooperate with any representative from any Federal, State or local regulatory agency who may visit the job site and shall provide immediate notification to the Contracting Officer, who shall accompany them on any subsequent site inspections. The Contractor shall complete, maintain, and make available to the Contracting Officer, station, or regulatory agency personnel all documentation relating to environmental compliance under applicable Federal, State and local laws and regulations. The Contractor shall immediately notify the Contracting Officer if a Notice of Violation (NOV) is issued to the Contractor.

The Contractor shall be responsible for all damages to persons or property resulting from Contractor fault or negligence as well as for the payment of any civil fines or penalties which may be assessed by any Federal, State or local regulatory agency as a result of the Contractor's or any subcontractor's violation of any applicable Federal, State or local environmental law or regulation. Should a Notice of Violation (NOV), Notice of Noncompliance (NON), Notice of Deficiency (NOD), or similar regulatory agency notice be issued to the Government as facility owner/operator on account of the actions or inactions of the Contractor or one of its subcontractors in the performance of work under this contract, the Contractor shall fully cooperate with the Government in defending against regulatory assessment of any civil fines or penalties arising out of such actions or inactions.

1.8 ENVIRONMENTAL PROTECTION PLAN

Five days after the award of contract, the Contractor shall meet with the Contracting Officer to discuss the proposed Environmental Protection Plan and develop a mutual understanding relative to the details of environmental protection, including measures for protecting natural resources, required reports, and other measures to be taken. The Environmental Protection Plan shall be submitted in the following format and shall, at a minimum, address the following elements (also refer to paragraph entitled "Protection of Natural Resources" in this section):

- a. Description of the Environmental Protection Plan
 - (1) General overview and purpose
 - (2) General site information
- b. Protection of Natural Resources
 - (1) Land resources
 - (2) Tree protection
 - (3) Replacement of damaged landscape features
 - (4) Temporary construction
 - (5) Fish and wildlife resources
 - (6) Wetland areas
- c. Protection of Historical and Archaeological Resources
 - (1) Objectives
 - (2) Methods
- d. Storm Water Management and Control
 - (1) Ground cover
 - (2) Erodible soils
 - (3) Temporary measures
 - (a) Mechanical retardation and control of runoff
 - (b) Vegetation and mulch
 - (4) Storm Water Pollution Prevention Measures and Notice of Intent 40 CFR 122.26, EPA 832-R-92-005. Provide a "Storm Water Pollution Prevention Plan" (SWPPP) for the project. The SWPPP shall meet the requirements of the State of Maryland general permit for storm water discharges from construction sites. Submit the SWPPP along with any required Notice of Intent, Notice of Termination, and

appropriate permit fees, via the Contracting Officer, to the appropriate State agency for approval, a minimum of 14 calendar days prior to the start of construction. A copy of the approved SWPPP shall be kept at the construction on-site office, and continually updated as regulations require to reflect current site conditions.

- (a) Identify potential sources of pollution which may be reasonably expected to affect the quality of storm water discharge from the site.
 - (b) Describe and ensure implementation of practices which will be used to reduce the pollutants in storm water discharge associated with industrial activity at the construction site.
 - (c) Ensure compliance with terms of state general permit for storm water discharge.
 - (d) Select applicable management practices from EPA 832-R-92-005.
 - (e) Provide completed copy of "Notice of Intent" and "Notice of Termination" except for effective date.
- e. Prevention of Releases to the Environment
- (1) Procedures to prevent releases to the environment
 - (2) Notifications in the event of a release to the environment
- f. Protection of the Environment from Waste Derived from Contractor Operations
- (1) Control and disposal of solid and sanitary waste
 - (2) Control and disposal of hazardous waste (Hazardous Waste Management Section)

This item shall consist of the management procedures for all hazardous waste to be generated. The elements of those procedures shall coincide with the Activity Hazardous Waste Management Plan. A copy of the Activity Hazardous Waste Management Plan will be provided by the Contracting Officer. As a minimum, include the following:

- (a) Procedures to be employed to ensure a written waste determination is made for appropriate wastes which are to be generated;
- (b) Sampling/analysis plan;
- (c) Methods of hazardous waste accumulation/storage (i.e., in tanks and/or containers);
- (d) Management procedures for storage, labeling, transportation,

and disposal of waste (treatment of waste is not allowed unless specifically noted);

(e) Management procedures and regulatory documentation ensuring disposal of hazardous waste complies with Land Disposal Restrictions (40 CFR 268);

(f) Management procedures for recyclable hazardous materials such as lead-acid batteries, used oil, and the like;

(g) Used oil management procedures in accordance with 40 CFR 279;

(h) Pollution prevention\hazardous waste minimization procedures;

(i) Plans for the disposal of hazardous waste by permitted facilities;

(j) Procedures to be employed to ensure all required employee training records are maintained.

1.8.1 Environmental Protection Plan Review

Fourteen days after the environmental protection meeting, submit the proposed Environmental Protection Plan for further discussion, review, and approval. Commencement of work shall not begin until the environmental protection plan has been approved.

1.9 UNFORESEEN HAZARDOUS OR REGULATED MATERIAL

All known hazardous or regulated materials are indicated in the contract documents. If material that is not indicated in the contract documents is encountered that may be dangerous to human health upon disturbance during construction operations, stop that portion of work and notify the Contracting Officer immediately. Intent is to identify materials such as PCB, lead paint, mercury, petroleum products, and friable and nonfriable asbestos. Within 14 calendar days the Government will determine if the material is hazardous. If the material is not hazardous or poses no danger, the Government will direct the Contractor to proceed without change. If the material is hazardous and handling of the material is necessary to accomplish the work, the Government will issue a modification pursuant to "FAR 52.243-4, Changes" and "FAR 52.236-2, Differing Site Conditions."

1.10 CONTRACTOR HAZARDOUS MATERIAL INVENTORY LOG

Submit the "Contractor Hazardous Material Inventory Log" (copy at end of section), which provides information required by (EPCRA Sections 312 and 313) along with corresponding Material Safety Data Sheets (MSDS) to the Contracting Officer at the start and at the end of construction (30 days from final acceptance), and update no later than January 31 of each calendar year during the life of the contract. Documentation for any spills/releases, environmental reports or off-site transfers may be requested by the Contracting Officer.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.1 PROTECTION OF NATURAL RESOURCES

Preserve the natural resources within the project boundaries and outside the limits of permanent work. Restore to an equivalent or improved condition upon completion of work. Confine construction activities to within the limits of the work indicated or specified.

3.1.1 Land Resources

Except in areas to be cleared, do not remove, cut, deface, injure, or destroy trees or shrubs without the Contracting Officer's permission. Do not fasten or attach ropes, cables, or guys to existing nearby trees for anchorages unless authorized by the Contracting Officer. Where such use of attached ropes, cables, or guys is authorized, the Contractor shall be responsible for any resultant damage.

3.1.1.1 Protection of Trees

Protect existing trees which are to remain and which may be injured, bruised, defaced, or otherwise damaged by construction operations. Remove displaced rocks from uncleared areas. By approved excavation, remove trees with 30 percent or more of their root systems destroyed.

3.1.1.2 Replacement

Remove trees and other landscape features scarred or damaged by equipment operations, and replace with equivalent, undamaged trees and landscape features. Obtain Contracting Officer's approval before replacement.

3.1.2 Water Resources

3.1.2.1 Oily and Hazardous Substances

Prevent oil or hazardous substances from entering the ground, drainage areas, or navigable waters. In accordance with 40 CFR 112, surround all temporary fuel oil or petroleum storage tanks with a temporary berm or containment of sufficient size and strength to contain the contents of the tanks, plus 10 percent freeboard for precipitation. The berm shall be impervious to oil for 72 hours and be constructed so that any discharge will not permeate, drain, infiltrate, or otherwise escape before cleanup occurs.

3.1.3 Fish and Wildlife Resources

Do not disturb fish and wildlife. Do not alter water flows or otherwise significantly disturb the native habitat adjacent to the project and critical to the survival of fish and wildlife, except as indicated or specified.

3.2 HISTORICAL AND ARCHAEOLOGICAL RESOURCES

Carefully protect in-place and report immediately to the Contracting Officer historical and archaeological items or human skeletal remains discovered in the course of work. Upon discovery, notify the Contracting Officer. Stop work in the immediate area of the discovery until directed by the Contracting Officer to resume work. The Government retains ownership and control over historical and archaeological resources.

3.3 EROSION AND SEDIMENT CONTROL MEASURES

3.3.1 Burnoff

Burnoff of the ground cover is not permitted.

3.3.2 Protection of Erodible Soils

Immediately finish the earthwork brought to a final grade, as indicated or specified. Immediately protect the side slopes and back slopes upon completion of rough grading. Plan and conduct earthwork to minimize the duration of exposure of unprotected soils.

3.3.3 Temporary Protection of Erodible Soils

Use the following methods to prevent erosion and control sedimentation:

3.3.3.1 Mechanical Retardation and Control of Runoff

Mechanically retard and control the rate of runoff from the construction site. This includes construction of diversion ditches, benches, berms, and use of silt fences and straw bales to retard and divert runoff to protected drainage courses.

3.3.3.2 Vegetation and Mulch

Provide temporary protection on sides and back slopes as soon as rough grading is completed or sufficient soil is exposed to require erosion protection. Protect slopes by accelerated growth of permanent vegetation, temporary vegetation, mulching, or netting. Stabilize slopes by hydroseeding, anchoring mulch in place, covering with anchored netting, sodding, or such combination of these and other methods necessary for effective erosion control.

- a. Seeding: Provide new seeding where ground is disturbed. Include topsoil or nutriment during the seeding operation necessary to establish a suitable stand of grass.

3.4 CONTROL AND DISPOSAL OF SOLID WASTES

Pick up solid wastes, and place in covered containers which are regularly emptied. Do not prepare or cook food on the project site. Prevent contamination of the site or other areas when handling and disposing of wastes. At project completion, leave the areas clean. Recycling is

encouraged and can be coordinated with the Contracting Officer and the activity recycling coordinator. Remove all solid waste (including non-hazardous debris) from Government property and dispose off-site at an approved landfill. Solid waste disposal off-site must comply with most stringent local, State, and Federal requirements including 40 CFR 241, 40 CFR 243, and 40 CFR 258. Contractor shall be responsible for obtaining and paying for all dumping permits and tipping fees.

3.4.1 Dumpsters

Equip dumpsters with a secure cover and paint the standard base color. Keep cover closed at all times, except when being loaded with trash and debris. Locate dumpsters behind the construction fence or out of the public view. Empty site dumpsters at least once a week, or as needed to keep the site free of debris and trash. If necessary, provide 55 gallon trash containers painted the darker base color to collect debris in the construction site area. Locate the trash containers behind the construction fence or out of the public view. Empty trash containers at least once a day. For large demolitions, large dumpsters without lids are acceptable but should not have debris higher than the sides before emptying.

3.5 CONTROL AND DISPOSAL OF HAZARDOUS WASTES

3.5.1 Hazardous Waste/Debris Management

The Contractor shall identify all construction activities which will generate hazardous waste/debris. The Contractor must provide a documented waste determination for all resultant waste streams. Hazardous waste/debris shall be identified, labeled, handled, stored, and disposed of in accordance with all Federal, State, and local regulations including 40 CFR 261, 40 CFR 262, 40 CFR 263, 40 CFR 264, 40 CFR 265, 40 CFR 266, and 40 CFR 268. Hazardous waste shall also be managed in accordance with the approved Hazardous Waste Management Section of the Environmental Protection Plan. Store hazardous wastes in approved containers in accordance with 49 CFR 173 and 49 CFR 178. Hazardous waste generated within the confines of Government facilities shall be identified as being generated by the Government. Prior to removal of any hazardous waste from Government property, all hazardous waste manifests must be signed by activity personnel from the Station Environmental Office. No hazardous waste shall be brought onto Government property. Provide to the Contracting Officer a copy of waste determination documentation for any solid waste streams that have any potential to be hazardous waste or contain any chemical constituents listed in 40 CFR 372-SUBPART D. For hazardous wastes spills, verbally notify the Contracting Officer immediately.

3.5.1.1 Regulated Waste Storage/Satellite Accumulation/90 Day Storage Areas

If the work requires the temporary storage/collection of regulated or hazardous wastes, the Contractor shall request the establishment of a Regulated Waste Storage Area, a Satellite Accumulation Area, or a 90 Day Storage Area at the point of generation. The Contractor must submit a request in writing to the Contracting Officer providing the following information:

<u>Contract Number</u>	_____	<u>Contractor</u>	_____
<u>Haz/Waste or Regulated Waste POC</u>	_____	<u>Phone Number</u>	_____
<u>Type of Waste</u>	_____	<u>Source of Waste</u>	_____
<u>Emergency POC</u>	_____	<u>Phone Number</u>	_____

Location of the Site: _____
 (Attach Site Plan to the Request)

Attach a waste determination form. Allow ten working days for processing this request.

3.5.1.2 Disposition of Waste Containing Lead Based Paint

A summary of construction elements to be demolished that are coated with lead containing paint products can be found in Section 13283N "Removal and Disposal of Lead-Containing Paint." Assume that all painted surfaces coated with lead containing paint contain multiple layers of lead containing paint. Remove loose, flaky lead based paint in accordance with Section 13283N "Removal and Disposal of Lead-Containing Paint." Products with well-bonded lead based paint can be disposed of as ordinary solid waste if a representative sampling of the waste passes a TCLP test.

Test representative samples of solid waste from the demolition activities. The Contractor shall perform and pay for all required tests. Testing shall conform to the Toxic Characteristic Leaching Procedure (TCLP) with respect to lead sampling and shall be in accordance with 40 CFR 261. If the TCLP results show leachable lead of less than 5 ppm, dispose of the waste as construction debris. If the results are 5 ppm or above, dispose of the contaminated waste as hazardous material in accordance with 40 CFR 261 and Section 13283N "Removal and Disposal of Lead-Containing Paint."

3.5.2 Pollution Prevention/Hazardous Waste Minimization

The Contractor shall actively pursue minimizing the use of hazardous materials and the generation of hazardous waste while on-base. The Hazardous Waste Management Section of the Environmental Protection Plan shall include the Contractor's procedures for pollution prevention/hazardous waste minimization. For preparing this part of the plan, the Contractor may consult the activity Environmental Office for suggestions and to obtain a copy of the installation's pollution prevention/hazardous waste minimization plan for reference material. If no written plan exists, the Contractor may obtain information by contacting the Contracting Officer. The Contractor shall describe the types of the hazardous materials expected to be used in the construction when requesting information.

3.5.3 Hazardous Material Control

The Contractor shall include hazardous material control procedures in the Safety Plan. The procedures shall address and ensure the proper handling

of hazardous materials, including the appropriate transportation requirements. The Contractor shall submit a MSDS and estimated quantities to be used for each hazardous material to the Contracting Officer prior to bringing the material on base. Typical materials requiring MSDS and quantity reporting include, but are not limited to, oil and latex based painting and caulking products, solvents, adhesives, aerosol, and petroleum products. At the end of the project, the Contractor shall provide the Contracting Officer with the maximum quantity of each material that was present at the site at any one time, the dates the material was present, the amount of each material that was used during the project, and how the material was used. The Contractor shall also ensure that hazardous materials are utilized in a manner that will minimize the amount of hazardous waste that is generated. The Contractor shall ensure that all containers of hazardous materials have NFPA labels or their equivalent. Copies of the MSDS for hazardous materials shall be kept on site at all times and provided to the Contracting Officer at the end of the project. The Contractor shall certify that all hazardous materials removed from the site are hazardous materials and do not meet the definition of hazardous waste per 40 CFR 261.

3.5.4 Petroleum Products

Conduct the fueling and lubricating of equipment and motor vehicles in a manner that protects against spills and evaporation. All used oil generated on site shall be managed in accordance with 40 CFR 279. The Contractor shall determine if any used oil generated while on-site exhibits a characteristic of hazardous waste. In addition, used oil containing 1000 parts per million of solvents will be considered a hazardous waste and disposed of at Contractor's expense. Used oil mixed with a hazardous waste will also be considered a hazardous waste. All hazardous waste will be managed in accordance with the paragraph entitled Hazardous Waste/Debris Management of this section and shall be managed in accordance with the approved Environmental Protection Plan.

3.5.5 Releases/Spills of Oil and Hazardous Substances

Take precautions to prevent releases/spills of oil and hazardous substances. In the event of any releases of oil and hazardous substances, chemicals, or gases; immediately (within 15 minutes) notify the Base or Activity Fire Department, the activity's Command Duty Officer, and the Contracting Officer. The Contractor is responsible for verbal and written notifications as required by the federal 40 CFR 355, State, local regulations and Navy Instructions. Spill response shall be in accordance with 40 CFR 300 and applicable State and local regulations. Contain and clean up these spills without cost to the Government. If Government assistance is requested or required, the Contractor shall reimburse the Government for such assistance. Provide copies of the written notification and documentation that a verbal notification was made within 20 days. Maintain chemical response kits at the work site.

3.6 DUST CONTROL

Keep dust down at all times, including during nonworking periods. Sprinkle or treat, with dust suppressants, the soil at the site, haul roads, and

other areas disturbed by operations. Dry power brooming will not be permitted. Instead, use vacuuming, wet mopping, wet sweeping, or wet power brooming. Air blowing will be permitted only for cleaning nonparticulate debris such as steel reinforcing bars. Only wet cutting will be permitted for cutting concrete blocks, concrete, and bituminous concrete. Do not unnecessarily shake bags of cement, concrete mortar, or plaster.

3.7 ABRASIVE BLASTING

3.7.1 Blasting Operations

The use of silica sand is prohibited in sandblasting.

Provide tarpaulin drop cloths and windscreens to enclose abrasive blasting operations to confine and collect dust, abrasive, agent, paint chips, and other debris in accordance with the requirements specified. Perform work involving removal of hazardous material in accordance with 29 CFR 1910.

3.7.2 Disposal Requirements

Submit analytical results of the debris generated from abrasive blasting operations per paragraph entitled Laboratory Analysis of this section. Hazardous waste generated from blasting operations shall be managed in accordance with paragraph entitled "Hazardous Waste\Debris Management" of this section and with the approved HWMP. Disposal of non-hazardous abrasive blasting debris shall be in accordance with paragraph entitled, "Control and Disposal of Solid Wastes".

3.8 NOISE

Make the maximum use of low-noise emission products, as certified by the EPA. Blasting or use of explosives will not be permitted.

-- End of Section --

SECTION 01770N

CLOSEOUT PROCEDURES

PART 1 GENERAL

1.1 SUBMITTALS

Submit the following in accordance with Section 01330, "Submittal Procedures."

SD-10 Operation and Maintenance Data

Equipment/product warranty list; G

Submit Data Package 1 in accordance with Section 01781N, "Operation and Maintenance Data."

SD-11 Closeout Submittals

As-built drawings; G

1.2 PROJECT RECORD DOCUMENTS

1.2.1 As-Built Drawings

"FAC 5252.236-9310, Record Drawings."

1.3 EQUIPMENT/PRODUCT WARRANTIES

1.3.1 Equipment/Product Warranty List

Furnish to the Contracting Officer a bound and indexed notebook containing written warranties for equipment/products furnished under the contract, and prepare a complete listing of such equipment/products. The equipment/products list shall state the specification section applicable to the equipment/product, duration of the warranty therefor, start date of the warranty, ending date of the warranty, and the point of contact for fulfillment of the warranty. The warranty period shall begin on the same date as project acceptance and shall continue for the full product warranty period. Execute the full list and deliver to the Contracting Officer prior to final acceptance of the facility.

1.3.2 Equipment Warranty Tags and Guarantor's Local Representative

Furnish with each warranty the name, address, and telephone number of the guarantor's representative nearest to the location where the equipment and appliances are installed. The guarantor's representative, upon request of the station representative, shall honor the warranty during the warranty period, and shall provide the services prescribed by the terms of the warranty. At the time of installation, tag each item of warranted equipment with a durable, oil- and water-resistant tag approved by the

Contracting Officer. Attach tag with copper wire and spray with a clear silicone waterproof coating. Leave the date of acceptance and QC's signature blank until project is accepted for beneficial occupancy. Tag shall show the following information:

EQUIPMENT/PRODUCT WARRANTY TAG

Type of Equipment/Product _____
 Warranty Period _____ From _____ To _____
 Contract No. _____
 Inspector's Signature _____ Date Accepted _____

Construction Contractor:

Name: _____
 Address: _____
 Telephone: _____

Warranty Contact: _____

Name: _____
 Address: _____
 Telephone: _____

STATION PERSONNEL TO PERFORM ONLY OPERATIONAL MAINTENANCE

1.4 MECHANICAL TESTING AND BALANCING

All contract requirements of Section 15910N, "Direct Digital Control Systems," shall be fully completed, including all testing, prior to contract completion date. In addition, all contract requirements of Section 15950N, "HVAC Testing/Adjusting/Balancing," shall be fully completed, including testing and inspection, prior to contract completion date, except as noted otherwise in Section 15950N. The time required to complete all work and testing as prescribed by Sections 15910N and 15950N is included in the allotted calendar days for completion.

1.5 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.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

Not used.

-- End of Section --

SECTION 01781N

OPERATION AND MAINTENANCE DATA

PART 1 GENERAL

1.1 SUBMISSION OF OPERATION AND MAINTENANCE DATA

Submit Operation and Maintenance (O&M) Data specifically applicable to this contract and a complete and concise depiction of the provided equipment, product, or system. Organize and present information in sufficient detail to clearly explain O&M requirements at the system, equipment, component, and subassembly level. Include an index preceding each submittal. Submit in accordance with this section and Section 01330, "Submittal Procedures."

1.1.1 Package Quality

Documents must be fully legible. Poor quality copies and material with hole punches obliterating the text or drawings will not be accepted.

1.1.2 Package Content

Data package content shall be as shown in the paragraph titled "Schedule of Operation and Maintenance Data Packages." Comply with the data package requirements specified in the individual technical sections, including the content of the packages and addressing each product, component, and system designated for data package submission.

1.1.3 Changes to Submittals

Manufacturer-originated changes or revisions to submitted data shall be furnished by the Contractor if a component of an item is so affected subsequent to acceptance of the O&M Data. Changes, additions, or revisions required by the Contracting Officer for final acceptance of submitted data, shall be submitted by the Contractor within 30 calendar days of the notification of this change requirement.

1.2 TYPES OF INFORMATION REQUIRED IN O&M DATA PACKAGES

1.2.1 Operating Instructions

Include specific instructions, procedures, and illustrations for the following phases of operation:

1.2.1.1 Safety Precautions

List personnel hazards and equipment or product safety precautions for all operating conditions.

1.2.1.2 Operator Prestart

Include procedures required to set up and prepare each system for use.

1.2.1.3 Startup, Shutdown, and Post-Shutdown Procedures

Provide narrative description for Startup, Shutdown and Post-shutdown operating procedures including the control sequence for each procedure.

1.2.1.4 Normal Operations

Provide narrative description of Normal Operating Procedures. Include Control Diagrams with data to explain operation and control of systems and specific equipment.

1.2.1.5 Emergency Operations

Include Emergency Procedures for equipment malfunctions to permit a short period of continued operation or to shut down the equipment to prevent further damage to systems and equipment. Include Emergency Shutdown Instructions for fire, explosion, spills, or other foreseeable contingencies. Provide guidance and procedures for emergency operation of all utility systems including required valve positions, valve locations and zones or portions of systems controlled.

1.2.1.6 Operator Service Requirements

Include instructions for services to be performed by the operator such as lubrication, adjustment, inspection, and recording gage readings.

1.2.1.7 Environmental Conditions

Include a list of Environmental Conditions (temperature, humidity, and other relevant data) that are best suited for the operation of each product, component or system. Describe conditions under which the item/equipment should not be allowed to run.

1.2.2 Preventive Maintenance

Include the following information for preventive and scheduled maintenance to minimize corrective maintenance and repair.

1.2.2.1 Lubrication Data

Include preventative maintenance lubrication data, in addition to instructions for lubrication provided under paragraph titled "Operator Service Requirements":

- a. A table showing recommended lubricants for specific temperature ranges and applications.
- b. Charts with a schematic diagram of the equipment showing lubrication points, recommended types and grades of lubricants, and capacities.
- c. A Lubrication Schedule showing service interval frequency.

1.2.2.2 Preventive Maintenance Plan and Schedule

Include manufacturer's schedule for routine preventive maintenance, inspections, tests and adjustments required to ensure proper and economical operation and to minimize corrective maintenance. Provide manufacturer's projection of preventive maintenance work-hours on a daily, weekly, monthly, and annual basis including craft requirements by type of craft. For periodic calibrations, provide manufacturer's specified frequency and procedures for each separate operation.

1.2.3 Corrective Maintenance (Repair)

Include manufacturer's recommended procedures and instructions for correcting problems and making repairs.

1.2.3.1 Troubleshooting Guides and Diagnostic Techniques

Include step-by-step procedures to promptly isolate the cause of typical malfunctions. Describe clearly why the checkout is performed and what conditions are to be sought. Identify tests or inspections and test equipment required to determine whether parts and equipment may be reused or require replacement.

1.2.3.2 Wiring Diagrams and Control Diagrams

Wiring diagrams and control diagrams shall be point-to-point drawings of wiring and control circuits including factory-field interfaces. Provide a complete and accurate depiction of the actual job specific wiring and control work. On diagrams, number electrical and electronic wiring and pneumatic control tubing and the terminals for each type, identically to actual installation configuration and numbering.

1.2.3.3 Maintenance and Repair Procedures

Include instructions and a list of tools required to repair or restore the product or equipment to proper condition or operating standards.

1.2.3.4 Removal and Replacement Instructions

Include step-by-step procedures and a list required tools and supplies for removal, replacement, disassembly, and assembly of components, assemblies, subassemblies, accessories, and attachments. Provide tolerances, dimensions, settings and adjustments required. Instructions shall include a combination of text and illustrations.

1.2.3.5 Spare Parts and Supply Lists

Include lists of spare parts and supplies required for maintenance and repair to ensure continued service or operation without unreasonable delays. Special consideration is required for facilities at remote locations. List spare parts and supplies that have a long lead-time to obtain.

1.2.4 Corrective Maintenance Work-Hours

Include manufacturer's projection of corrective maintenance work-hours including requirements by type of craft. Corrective maintenance that requires completion or participation of the equipment manufacturer shall be identified and tabulated separately.

1.2.5 Appendices

Provide information required below and information not specified in the preceding paragraphs but pertinent to the maintenance or operation of the product or equipment. Include the following:

1.2.6 Parts Identification

Provide identification and coverage for all parts of each component, assembly, subassembly, and accessory of the end items subject to replacement. Include special hardware requirements, such as requirement to use high-strength bolts and nuts. Identify parts by make, model, serial number, and source of supply to allow reordering without further identification. Provide clear and legible illustrations, drawings, and exploded views to enable easy identification of the items. When illustrations omit the part numbers and description, both the illustrations and separate listing shall show the index, reference, or key number that will cross-reference the illustrated part to the listed part. Parts shown in the listings shall be grouped by components, assemblies, and subassemblies in accordance with the manufacturer's standard practice. Parts data may cover more than one model or series of equipment, components, assemblies, subassemblies, attachments, or accessories, such as typically shown in a master parts catalog

1.2.6.1 Warranty Information

List and explain the various warranties and include the servicing and technical precautions prescribed by the manufacturers or contract documents in order to keep warranties in force. Include warranty information for primary components such as the compressor of air conditioning system.

1.2.6.2 Personnel Training Requirements

Provide information available from the manufacturers that is needed for use in training designated personnel to properly operate and maintain the equipment and systems.

1.2.6.3 Testing Equipment and Special Tool Information

Include information on test equipment required to perform specified tests and on special tools needed for the operation, maintenance, and repair of components.

1.2.6.4 Contractor Information

Provide a list that includes the name, address, and telephone number of the General Contractor and each Subcontractor who installed the product or

equipment, or system. For each item, also provide the name address and telephone number of the manufacturer's representative and service organization most convenient to the project site. Provide the name, address, and telephone number of the product, equipment, and system manufacturers.

1.3 SCHEDULE OF OPERATION AND MAINTENANCE DATA PACKAGES

Furnish the O&M data packages specified in individual technical sections. The required information for each O&M data package is as follows:

1.3.1 Data Package 1

- a. Safety precautions
- b. Maintenance and repair procedures
- c. Warranty information
- d. Contractor information
- e. Spare parts and supply list

1.3.2 Data Package 2

- a. Safety precautions
- b. Normal operations
- c. Environmental conditions
- d. Lubrication data
- e. Preventive maintenance plan and schedule
- f. Maintenance and repair procedures
- g. Removal and replacement instructions
- h. Spare parts and supply list
- i. Parts identification
- j. Warranty information
- k. Contractor information

1.3.3 Data Package 3

- a. Safety precautions
- b. Normal operations
- c. Emergency operations

- d. Environmental conditions
- e. Lubrication data
- f. Preventive maintenance plan and schedule
- g. Troubleshooting guides and diagnostic techniques
- h. Wiring diagrams and control diagrams
- i. Maintenance and repair procedures
- j. Removal and replacement instructions
- k. Spare parts and supply list
- l. Parts identification
- m. Warranty information
- n. Testing equipment and special tool information
- o. Contractor information

1.3.4 Data Package 4

- a. Safety precautions
- b. Operator prestart
- c. Startup, shutdown, and post-shutdown procedures
- d. Normal operations
- e. Emergency operations
- f. Operator service requirements
- g. Environmental conditions
- h. Lubrication data
- i. Preventive maintenance plan and schedule
- j. Troubleshooting guides and diagnostic techniques
- k. Wiring diagrams and control diagrams
- l. Maintenance and repair procedures
- m. Removal and replacement instructions
- n. Spare parts and supply list

- o. Corrective maintenance man-hours
- p. Parts identification
- q. Warranty information
- r. Personnel training requirements
- s. Testing equipment and special tool information
- t. Contractor information

1.3.5 Data Package 5

- a. Safety precautions
- b. Operator prestart
- c. Start-up, shutdown, and post-shutdown procedures
- d. Normal operations
- e. Environmental conditions
- f. Preventive maintenance plan and schedule
- g. Troubleshooting guides and diagnostic techniques
- h. Wiring and control diagrams
- i. Maintenance and repair procedures
- j. Spare parts and supply list
- k. Testing equipments and special tools
- l. Warranty information
- m. Contractor information

PART 2 PRODUCTS

Not used

PART 3 EXECUTION

Not used

-- End of Section --

SECTION 10270
ACCESS FLOORING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Structural floor supported pedestal framing system.
- B. Removable floor panels.
- C. Access floor plenum divider.
- D. Accessories, including fascia panels, grilles, and threshold plates.
- E. System electrostatic grounding.

1.02 RELATED SECTIONS

- A. Section 16060 - Electrical Grounding and Bonding: Grounding and bonding of access floor system to building grounding system.

1.03 REFERENCES

- A. ANSI/ICC A117.1 - American National Standard for Accessible and Usable Buildings and Facilities; International Code Council; 1998.
- B. CISCA (AF) - Recommended Test Procedures for Access Floors; Ceilings & Interior Systems Construction Association; 1987.
- C. UL (FRD) - Fire Resistance Directory; Underwriters Laboratories Inc.; current edition.
- D. U.S. Federal Standard 209, Class 100 Air Cleanliness Limits.

1.04 PERFORMANCE REQUIREMENTS

- A. Pedestals:
 - 1. Maximum Axial Load: 5,000 lb (2,268 kg) without permanent deformation.
 - 2. Ultimate Strength: Not less than twice design load.
- B. Floor Panels: Conform to the following:
 - 1. Live Load: 250 lb/sq ft (11.9 kPa).
 - 2. Maximum Deflection: 0.04 inch (1 mm).
 - 3. Concentrated Load: 1250 lb on 1 sq in (467 kg on 710 sq mm) at any location

- with maximum deflection of 0.10 inch (2.54 mm).
4. Permanent Deformation: 0.02 inch (0.5 mm) maximum at design load.
 5. Ultimate Strength: Not less than twice design load.
- C. Lateral Stability: Design system for lateral stability in all directions, with or without panels in place.
- D. Surface Electrical Resistance: Maximum 1 ohm per panel.
- E. Access Flooring System: Test for the following criteria, using CISCA (AF) procedures:
1. Concentrated Load: 1250 lbs. and 3000 lbs. as indicated on the drawings.
 2. Rolling Loads: 1000lbs.

1.05 DESIGN REQUIREMENTS

- A. Access flooring system to achieve a minimum finished floor elevation 24 inches (600 mm) nominal height above building structural floor at the high point.
- B. Floor Panel Size: 24 x 24 inches (600 x 600 mm).

1.06 SUBMITTALS

- A. Product Data: Provide data for grid system, panels, and accessories; electrical resistance characteristics and ground connection requirements.
- B. Shop Drawings: Indicate floor layout, interruptions to grid, special sized panels, panels requiring drilling or cut-out for services, appurtenances or interruptions, edge details, elevation differences, grilles, and registers.
- C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- D. Manufacturer's Instructions: Indicate special procedures, perimeter conditions requiring special attention.
- E. Maintenance Data: Include recommended cleaning methods, cleaning materials, stain removal methods.

1.07 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the types of products specified in this section, with minimum three years of documented experience.
- B. Installer Qualifications: Company specializing in performing the type of work required

in this section, with minimum 3 years of experience.

1.08 REGULATORY REQUIREMENTS

- A. Conform to applicable code for flame resistance of panels.
- B. Conform to ANSI/ICC A117.1 for access for the handicapped.
- C. Electrical Grounding Connection: Listed and classified by Underwriters Laboratories as suitable for the purpose specified and indicated, see Section 16060.

1.09 EXTRA MATERIALS

- A. Provide four of each type of floor panel.
- B. Provide four spare pedestals and four stringers.
- C. Panel Lifting Devices: One, of manufacturer's standard type.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Access Flooring:
 - 1. Tate Access Floors, Inc; Product FF1250 and FF3000: www.tateaccessfloors.com.
 - 2. Or Approved Equal.

2.02 COMPONENTS

- A. Pedestals: Aluminum with flat bottom base plate, threaded supporting rod, vibration proof lock nut to permit 1-1/2 inch (38 mm) adjustment, manufacturer's standard finish.
- B. Frame Grid Stringers: Continuous type, consisting of aluminum channels, box, or tee sections.
- C. Perforated Floor Panels: Same material, size, and construction as floor panels with slide dampers for controlled air circulation.
 - 1. Cast aluminum, with ribbed stiffeners.
 - 2. Panel Edge: Vinyl trim, slip-on type.
 - 3. Floor Panel Finish Adhesive: Electrically conductive type recommended by floor finish manufacturer.

2.03 ACCESSORIES

- A. Plenum Dividers: Aluminum plate .080 inch (2 mm) thick.

B. Electrostatic Grounding Connectors: Solid copper.

2.04 FINISHING

A. Floor Panel Finish: 25,000 ohm to 1,000,000 ohm resistivity

1. Vinyl tile, static conductive type 1/8 inch (3 mm) thick, ; color as selected.

2.05 SOURCE QUALITY CONTROL

A. Fabrication Tolerances:

1. Floor Panel Flatness: Plus or minus 0.02 inch (0.5 mm) in any direction.
2. Floor Panel Width or Length From Specified Size: Plus or minus 0.02 inch (0.5 mm).
3. Floor Panel Squareness: Plus or minus 0.03 inch (0.8 mm) difference between opposite diagonal dimensions.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify field measurements are as shown on shop drawings.
- B. Verify that required utilities are available, in proper location, and ready for use.

3.02 PREPARATION

- A. Clean substrate surfaces.

3.03 INSTALLATION

- A. Install components in accordance with manufacturer's instructions.
- B. Secure pedestal base plate to subfloor with VOC compliant adhesive.
- C. Install additional pedestals where grid pattern is interrupted by room appurtenances or at cut-outs.
- D. Install stringers and floor panels on pedestals.
- E. Close field cut floor panels with edge trim.
- F. Cut holes in floor panels to accommodate ROICC equipment. Provide cable cut-out protection.

- G. Install plenum dividers to provide a positive air seal between structural floor and elevated floor.

3.04 ERECTION TOLERANCES

- A. Maximum Out of Level Floor Panel Tolerance: 1/16 inch in 10 ft (1.6 mm in 3 m), non-cumulative.

3.05 ADJUSTING

- A. Adjust pedestals to achieve a level floor and to assure adjacent floor panel surfaces are flush.

3.06 PROTECTION

- A. Do not permit traffic over unprotected floor surface.

END OF SECTION

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SECTION 13030

CLEAN ROOM WALL SYSTEMS

PART 1 GENERAL

1.01 DESCRIPTION

All labor, materials, equipment and services necessary to fabricate, furnish and erect the demountable metal framing system for clean room vertical wall panels. Work shall include but is not necessarily limited to the following:

- A. Universal reusable steel framing system, including all items such as clips, anchors, screws, attachments, supports, etc., incorporating steel factory-finished panels.
- B. Provide all reinforcing blocking and gasketing necessary to maintain the structural and acoustical requirements of the partition for all items included.
- C. Follow good safety and industrial hygiene practices during handling and installing of all products and systems. Take necessary precautions and wear the appropriate personal protective equipment as needed. Read material safety data sheets and related literature on products before installation.

1.02 REFERENCES

- A. American Society for Testing and Materials (ASTM).
 - 1. ASTM E72.
- B. U.S. Federal Standard 209, Class 100 Air Cleanliness Limits.
- C. American National Standards Institute, Inc.
 - 1. ANSI/BHMA A156.1-1988

1.03 QUALIFICATIONS OF INSTALLER

- A. Installation shall be by a previously approved, qualified and authorized installer of the manufacturer.

1.04 SUBMITTALS

- A. Product Data: Submittals required for the following items.
 - 1. Cleanroom Walls.

2. Cleanroom Doors.
 3. Cleanroom Door Hardware.
- B. Submit complete shop drawings and erection diagrams. Shop drawings shall give all pertinent information of construction method proposed, together with all required dimensions for the proper fitting for the connection with other work and materials, together with all special conditions as may be required to complete installation.
- C. Provide samples of all partition finishes and partition and/or parts. Samples are subject to the approval of the owner's representative. Approved samples shall become the standard for acceptance of all installed work.
- D. Provide certification of compliance, together with test results for the various requirements herein specified, including sound ratings, structural, fire ratings and other performance requirements.
1. A notarized certification shall be made separately for each major category listed above, and shall be on a form satisfactory to the owner's representative and all governing authorities.
- E. Provide necessary test results for sound ratings, structural requirements, fire ratings, and as outlined in the following:
1. Sound Ratings for Steel-Faced Partition—Honeycomb Core.
 - a. Sound transmission loss ratings of 40 for all walls. Perform tests in accordance with ASTM E-90 test procedures.
 - b. Test by recognized independent testing laboratory acceptable to the owner's representative.
 - c. In-house tests are not acceptable.
 - d. Test specimen shall be at least 9'-0" x 14'-0", of manufacturer's current product and include all standard components such as panels, end filters, etc.
 - e. Test installation shall have normal field variations in floor, wall, ceiling, and end walls.
 - f. Submit written test results to the owner's representatives within thirty (30) days after award of this subcontract.
 2. Structural requirements for Steel-Faced Partition—Honeycomb Core:
 - a. Fracture test: No visual damage when subjected to a 1½" diameter 8-ounce steel ball dropped from a height of 18" onto a horizontal panel three times.
 - b. Impact test: Perform impact load tests on an assembled partition in accordance with ASTM E 72. Perform tests on three duplicate specimens. Point of impact shall be on panel midway between studs. From a drop of 3'-0", instantaneous deflection of upper face not to exceed 15/16". Set not to exceed 3/32".
 - c. Uniform load test: Calculate or test partitions to prove they will resist 35 lbs.

per square foot in bending and that deflection will not exceed L/360 with a 10 lbs. per square foot load, with not more than .006" permanent set. Test procedure to be ASTM E-72.

- d. Moment load test: Using full-height partition sample, attach to face of a single panel two adjustable shelf standards. Shelf standard attachments will not protrude into opposite face of partition, and be fastened to panel unit verticals. Test panel will not be reinforced. At vertical mid-point of panel, attach three 10" shelves 12" apart. Load shelves to a total weight of 1000# per panel plate on one side only. Panels shall not open visibly at joints and deflection of panels in any direction shall be less than .032" while loaded.
3. Fire rating requirements for steel-faced partition: Provide independent laboratory certification that wall system has been tested for fire endurance and hose-stream in accordance with ASTM E119 and certify results.

F. Operation and Maintenance Data: Submittals required for the following items:

1. Manufacturers of the products specified herein shall include complete instructions with their products giving directions for replacing renewable parts of their products as well as instructions for cleaning the finished surfaces of such products.

1.05 PRODUCT DELIVERY, HANDLING AND STORAGE

- A. Deliver materials in their original unopened packages.
- B. Exercise care in handling partition components to prevent damage.
- C. Store materials in an enclosed shelter, protected from damage and from the elements.

PART 2 PRODUCTS

2.01 MANUFACTURER

- A. Provide all demountable partitions specified in this section from the same manufacturer.
- B. Demountable partitions shall be the USG Interiors, Inc. CLEAN ROOM Wall System for clean room environments as manufactured by USG Interiors, Inc. or an approved equal.
- C. Demountable partitions are named to establish standard of quality.

2.02 CONSTRUCTION AND MATERIALS FOR WALL SYSTEMS

- A. Partition components shall assemble into a rigid structure with tight straight-line joints. Completed installation shall be free of exposed bolts, nuts and rivets. All units shall be readily removable from either side without disturbing adjacent units. Three-way and four-way intersections shall be made at any point without regard to module.
- B. It shall be possible for solid steel partition runs to intersect each other at two-, three- and four- way conditions with clean full panel connections that shall not require the use of wall channels or any other external trim extending beyond the face of the partition. All door frames shall be locked into the system by means of standard floor-to-floor deck above vertical framing members occurring in both jambs.
- C. Partition studs for metal panels. Extend studs from floor to floor above and adjust to variation in height by means of an 8" long, 20-gauge upper stud extension. Form studs of two 24-gauge steel members clinched together and punched 6" on center to accommodate the passage of utility lines. Form each stud to provide a positive continuous mechanical interlock with the panel units. Studs at door jambs and head shall be two 18-gauge steel.
- D. Partitions extended from sub-floor of access floor to concrete slab of floor of deck above the ceiling. Studs shall provide continuous mechanical interlock for metal panels and provide continuous gasket in the mechanical interlock. Provide accessible walls below finished ceiling without disturbing panels above or below.
- E. Accessible Steel Panels Units: Steel panels shall be ½" thick by 24" wide and available in the following constructions for initial and future application. Steel panels shall consist of a 24-gauge steel face laminated to the following:

- 1. Metal Honeycomb Core, Metal-backed

Vertical edges of panel shall have continuously roll-formed edges to automatically and mechanically interlock and align to studs to form a tight single-line joint. Provide standard panels which assemble into a partition with tight single-line joints. If required, fill outside face of all joints with manufacturer's approved clear silicone sealant. Panels secured to the framing system by battens are unacceptable. Horizontal cut-down of panels to accommodate lower elevations shall be possible. Panels shall be 24" wide, with an allowable width tolerance of ± 0.005 ". Thickness ½" nom. with an allowable thickness tolerance of $+0.018$ ", -0.018 ". Length as required, with an allowable length tolerance of $\pm 1/16$ ". All panels of the same type shall be interchangeable in the field without damage to adjoining panel units.

- F. Intersections: Where full steel runs intersect each other, it shall be possible to make full panel, single-line connections without the use of exposed wall channels or any other external trim. Provide light and sound seals applied to wall channels. Provide wall panels abutting or intersecting foreign materials with electrolytic isolation.
- G. Corners: Provide inside and outside corners which snap into the studs in the same

manner to maintain flush, single-line integrity of the system.

- H. Gaskets: Partition track shall be installed with a foam gasket. Seal at head shall be gasket similar to that used at floor. Sizes shall be as required.
- I. Utility provisions: Provide 6" partitions with a 5" cavity between panels as indicated on drawings. Studs shall be punched 6" on center to provide horizontal passage of electrical and utility lines.
- J. Door frames: Reversible steel door frames shall be completely free of exposed fasteners. Door frames shall be mortised for template butts and ANSI Standard A5111 hinges (4 per door).
- K. Base: Base shall be 1-3/8" steel mold which continuously and positively locks into floor track with no fasteners.
 - 1. Option I: Base shall be 3¾" PVC base secured with a steel base channel with no fasteners.
 - 2. Option II: Vinyl or rubber cove base by flooring contractor optional.
- L. Finish: Provide uniform color, factory-applied panel finish of the following type.
 - 1. Type 1: Finish shall be manufacturer's standard backed-on enamel coating.Colors to be selected from manufacturer's standard colors. Submit color samples to be selected by owner's representative.
- M. Doors: Provide 1¾" thick flush hollow metal doors with insulated core.
 - 1. Glazing: .25-inch (6 mm) tempered glass.
 - a. Provide yellow tinted plastic film on all glazing.
 - 2. Gaskets: As manufactured by Poron or approved equal.
 - 3. Finish: match wall panels (baked-on enamel).
- N. Door Hardware: Provide hardware compatible with cleanroom environment.
 - 1. Select components to be non-particulating.
 - 2. Hinges: ANSI/BHMA A5111 (4 per door).
 - 3. Closers: LCN 3133 Concealed, or Approved Equal. Operation of closer shall match or exceed the room pressure.
 - 4. Passage Sets: Schlage D10S, or approved equal to match current project.

PART 3 EXECUTION

3.01 INSTALLATION

- A. All installation methods shall be in accordance with the latest recommendations of the

manufacturer and in conformance with this specification and shop drawings. Floor track shall be accurately aligned at floor in accordance with plans, and securely anchored. Position studs vertically, spaced as required. Locate studs adjacent to door frames, partition intersections and corners. Lock wall panels securely to studs, flush with adjacent panels.

- B. Install door, hardware and seals, and adjust for proper operation.

3.02 ACCEPTANCE

- A. Materials found to be defective or improperly installed shall be replaced.

3.04 CLEANING

- A. Periodically during work and after completion of work, clean up and remove all debris from jobsite. Remove all rubbish and cartons and leave jobsite broom clean.

3.05 PROTECTION AND REPAIR

- A. Protect the work of others during execution of work, and repair any damages caused.

END OF SECTION

SECTION 13050

CLEANROOM CEILING SYSTEM

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: The work specified in this Section consists of constructing cleanroom ceiling systems for the project.
- B. Related Sections:
 - 1. Division 13030: Cleanroom Wall Systems.

1.02 REFERENCES

- A. Institute of Environmental Sciences and Technology (IEST):
 - 1. IEST Recommended Practice IEST-RP-CC-001, HEPA Filters
- B. Underwriters' Laboratories, Inc. (UL): Listings and Labels shall govern the quality and performance of certain Products as specified herein.
 - 1. UL 900;
- C. U.S. Federal Standard 209, Class 100 Air Cleanliness Limits.

1.03 SUBMITTALS

- A. Product Data: Submittals required for the following items:
 - 1. Cleanroom Ceiling System Components.
 - 2. Lighting Components.
 - a. Submit total harmonic distortion data.
 - 3. HEPA filters.
 - 4. Urethane Gel.
- B. Shop Drawings: Submittals required for the following items:
 - 1. Dimensioned cleanroom ceiling layout indicating grid orientation, suspension system, spacing and outside to outside dimensions of installed system. Include lighting arrangement, and sprinkler locations.
 - 2. Provide detailed wiring plan.
 - 3. Provide details of the ceiling plenum divider wall and attachment to the ceiling grid.
- C. Operation and Maintenance Data: Submittals required for the following items:
 - 1. Manufacturers of the products specified herein shall include complete instructions with their products giving directions for replacing renewable parts of their

products as well as instructions for cleaning the finished surfaces of such products.

PART 2 PRODUCTS

2.01 CLEANROOM CEILING SYSTEM FOR GEL SEAL HEPA FILTERS (CLEANROOMS 104)

- A. Ceiling System: Provide a factory fabricated ceiling system consisting of ceiling grid and lighting from a single manufacturer.
 - 1. Provide integrated system suitable for the installation of top load, gel seal HEPA filters.
- B. Ceiling Grid: Two-inch extrusions with integral upturned flange for wet gel seal installation of filters.
 - 1. Provide main runners that are factory notched for cross tees.
 - 2. Provide continuous track as part of extrusion on main runners for field attachment of suspension devices.
 - 3. Provide continuous ¼-20 screw boss on cleanroom side of main runners for attachment of strip curtains to main runners at locations indicated on the Drawings.
 - 4. Finish grid members with white epoxy powder coat.
 - 5. Provide perimeter channel with blank cover and zee channel for closure of ceiling system to perimeter walls.
- C. Support Hardware: Threaded rod and turnbuckles.
 - 1. Provide 3/8-16 hardware for suspension connections between "Unistrut" channels and main runners of Clean Room Ceiling System.
 - 2. Provide chrome finish.
 - 3. Provide "Unistrut" channels suspended from structure above, channels to be perpendicular to the main runners of the ceiling. "Unistrut" channels, hanger rods, connections, spacing, sizing, and arrangement proposed by the contractor shall be certified by a professional engineer employed by the contractor.
- D. Sprinkler Assemblies: Provide FM approved sprinkler fixtures.
 - 1. Provide 6-foot flex hose with "O" ring seal through cross member.
 - 2. Provide 6-inch chrome plated steel pipe extension into cleanroom and chrome plated pendant heads.
 - 3. The temperature rating of the sprinklers shall be 135°F (57°C) except where varying temperature ratings are required by Code or the approved authorities.
- E. Filter Sealant Gel: Provide urethane gel.

1. Provide in quantity required to fill grid system to cleanroom ceiling manufacturer's recommended levels.

F. Lighting: Provide factory-assembled lighting within main runners.

1. Provide UL listed light track with quick connect electrical fittings and all integral wiring. Wiring to be copper, NEC type as required.
2. Provide specular lamp reflectors and snap-in, clear acrylic, teardrop lenses.
3. Provide lamp sockets/holders for bi-pin T-8 lamps.
4. Provide electronic ballast with less than 5% total harmonic distortion.
5. Provide junction boxes at the end of each main run with pigtails, knockout for $\frac{3}{4}$ " conduit connection, grounding lug, and cover plate.
6. Lamps to be provided under Electrical Division.

G. Basis of Design: Gordon Cleanroom Products, 55 MM Grid System.

H. Acceptable Manufacturers:

1. Gordon Cleanroom Products
2. Huntair, Inc.
3. Or Approved Equal

2.03 HEPA FILTERS

A. Provide plenum HEPA filters as required:

1. Production Area Environment: Fabricate all HEPA filters in a minimum Class 10,000 (at rest) production area.
2. Packaging and Labeling: Seal all filters in a polyethylene bag prior to leaving the production area. Apply a bar code label to each filter at the beginning of manufacturing for the purpose of documenting the media lot used and the testing results.
3. Filter Frames: Fabricate filter frames from aluminum extrusions with a clear anodized finish.
4. Provide knife edge on the downstream perimeter.
 - a. Provide machine pleated filter element with a minimum of 7.5 folds per inch using a continuous sheet of media.
 - b. Provide 2 inch deep filter pack with a maximum pressure drop of 0.31 inches with a face velocity of 60 CFM per square foot.
 - c. Utilize raised impressions on the media to support adjacent folds.
 - d. Continuously bond filter element to filter frame using a fire-retardant, UL-classified solid urethane. Utilize phosphorus-free urethane as tested by gas chromatography using the head space technique at 75 deg. C.

- e. Fabricate filters in compliance with UL-900 Class 1 and Factory Mutual standards.
- B. Testing
- 1. Perform leak and efficiency testing on each filter using polystyrene latex spheres, (DOP or other liquid-based aerosol is prohibited).
 - a. Certify that each filter has a minimum removal efficiency of 99.99% on 0.3 micron particle size as specified by IEST-RP-CC-001 for Type C filters.
 - b. Scan test the face and perimeter of each filter and certify that the filter is free from leaks greater than 0.01% of the test challenge.
- C. Basis of Design
- 1. Plenum HEPA filters: Flanders Dimple Pleat Gel Sealcturer:
- D. Acceptable Manufacturers:
- 1. Flanders Filters, Inc.
 - 2. American Air Filter, Inc.
 - 3. CamFarr, Inc.
 - 4. Or Approved Equal.

PART 3 EXECUTION

3.01 PERFORMANCE

- A. Installation Instructions: Install those Products, as specified previously under PART 2 and not specifically covered for installation herein under PART 3, in strict accordance with manufacture's installation instructions and at locations on the Drawings.
- B. When manufacturer's installation instructions do not exist, and when installed locations are not specifically indicated, perform work in accordance with current accepted Trade practices concerning installation of such Products.

3.02 SUSPENSION SYSTEM

- A. Install "Unistrut" suspension system of hanger rods and channels. Channels to be perpendicular to main runners of Cleanroom Ceiling System.
- B. Install hangers and channel level and in alignment using laser equipment. "Unistrut" channels shall be in alignment with the indicated locations of the threaded rod and turnbuckle connections from the main runners of the ceiling system. .

3.03 CLEANROOM CEILING SYSTEM INSTALLATION

- A. Where indicated coordinate exact location of ceiling system to properly align with cleanroom wall system.
- B. Install ceiling system square and level using laser alignment.

- C. Fill ceiling system with gel in strict accordance with manufacturer's installation instructions.

3.04 HEPA FILTER INSTALLATION

- A. Receiving: Immediately upon receipt visually inspect each filter carton for shipping damage such as crushed corners or sides, punctures or other deformation that would indicate possible damage to filter media, frame or any part of the filter. Open any deformed cartons and assess damage to filter. Segregate damaged filters from non-damaged cartons and return to manufacturer.
- B. Handling and Inspection: Minimize handling of filters after inspection. Store filters on site in upright position as indicated on cartons until installation. Minimize to the maximum extent possible:
 - 1. Dropping of cartons.
 - 2. Vibration.
 - 3. Excessive movement.
 - 4. Rough handling.
- C. Installation in Ceiling Grid: Install filters in ceiling grid in accordance with manufacture's instructions.
 - 1. Inspect grid section for receiving gel seal filters for proper gel level and any foreign substances.
 - 2. Transport filters to cleanroom in sealed cartons, remove from carton and remove from bag.
 - 3. Using extreme care not to touch filter media raise filter above filter grid and lower into grid.

END OF SECTION

SECTION 15050

BASIC MECHANICAL MATERIALS AND METHODS

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Dielectric fittings.
 - 2. Mechanical sleeve seals.
 - 3. Equipment nameplate data requirements.
 - 4. Mechanical Identification.
 - 5. Mechanical demolition
 - 6. Cutting and patching.
 - 7. Field painting, Touchup painting and finishing.
 - 8. Access Doors
 - 9. Welding procedures
 - 10. Grouting
 - 11. Joint Sealants, Amine-Free

1.02 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawl spaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors, or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants, but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- F. The following are industry abbreviations for plastic materials:
 - 1. ABS: Acrylonitrile-butadiene-styrene plastic.
 - 2. CPVC: Chlorinated polyvinyl chloride plastic.
 - 3. NP: Nylon plastic.
 - 4. PE: Polyethylene plastic.
 - 5. PVC: Polyvinyl chloride plastic.
 - 6. The following are industry abbreviations for rubber materials:
 - 7. CR: Chlorosulfonated polyethylene synthetic rubber.

8. EPDM: Ethylene propylene diene terpolymer rubber.

1.03 SUBMITTALS

- A. General: Submit in accordance with Division 1 requirements. Submit in sufficient detail to show full compliance with Contract Documents.
- B. Product Data:
 - 1. Submit manufacturer's product data for each product and material
 - 2. Indicate manufacturer, trade names, and model numbers, components, arrangement, and accessories being provided.
 - 3. Include applicable literature, catalog material or technical brochures.
 - 4. Include material and equipment specifications, sizes, types, dimensions, weights, rated capacities, and performance.
 - 5. Include utility requirements for wiring, piping, and service connection data, motor sizes complete with electrical characteristics.
- C. Shop Drawings:
 - 1. Include dimensional data for rough in and installation instructions.
 - 2. Indicate typical layout including dimensions and utility connections.
 - 3. Submit Fabrication Drawings for ductwork construction and connections to equipment.
- D. Quality Assurance/Control Submittals:
 - 1. Design Data
 - 2. Test Reports
 - 3. Certificates
 - 4. Manufacturers Instructions and Field Reports
- E. Closeout Submittals:
 - 1. Record Documents
 - 2. Operation and Maintenance Data: Submit operation and maintenance manual(s) for all major mechanical components and all equipment with moveable parts.

1.04 DRAWING INTERPRETATION AND COORDINATION

- A. Drawings are diagrammatic and indicate the general arrangement of systems and equipment, unless indicated otherwise by dimensions or Detail Drawings.
- B. Plans are intended to show size, capacity, approximate location, direction, and general relationship of one work phase to another, but not the exact detail or arrangement.
- C. For locations of building elements, refer to dimensioned Architectural and Structural Drawings and perform field measurements to verify exact locations.

- D. Equipment outlines shown on Detail Drawings, or dimensions indicated anywhere on the Drawings, are limiting dimensions. Equipment exceeding approximate dimensions indicated by equipment outlines on Detail Drawings and any equipment or arrangements that reduce indicated clearances or exceed specific equipment dimensions may not be used.
- E. Interferences:
1. The Contractor is responsible for modifying the work with offsets, bends or other fittings to avoid minor interferences and structural obstruction. Perform such modifications at no increase in Contract Price.
 2. Construct Mechanical Systems when and in a manner not to delay or interfere with other operations of work in the Project.
 3. Prior to making Mechanical installations, coordinate Mechanical Work locations with other operations of work, especially in congested areas, such as mechanical equipment rooms and above hung ceilings (if any).
 4. In the event that interferences develop, the COR's decision will be final and no additional compensation will be allowed for relocation of Mechanical Products.
- F. Electrical Interface:
1. Install or mount, as work of Division 15 - Mechanical, such electrical components or apparatus as provided by Product manufacturer's specified under the various Sections of this Division 15.
 2. Power wiring, including final connections of such to primary electrical service devices of Products specified shall NOT be performed as work of Division 15 - Mechanical, but as work of Division 16 - Electrical.
 3. Power wiring, including final connections of such, from the electrical service devices to the electrical components of Products specified shall be performed as work of Division 16 - Electrical.
- G. Contract Interface:
1. Work Performed in Cooperation With Other Contracts: The responsibility for performing Work of this Contract in cooperation with Work of other Contracts rests solely with the HVAC Contractor.
 2. Make connections of piping systems and duct systems specified in the various Sections of this Contract to those systems or installations of other Contracts requiring such connections.
 3. These connections are generally indicated as Contract Breaks on the Drawings.
 4. Perform installation work of Products of this Contract such as ventilating equipment, heat generating equipment, heating and air conditioning units, and such other associated HVAC Products in cooperation with the Work of the General Construction Contract.
- H. HVAC Control System Electrical Interface; Refer to Section 15915 for control system electrical interface requirements.
- I. Electrical Service Devices:

1. Motor starters and disconnect switches for the majority of the Mechanical Equipment are provided as work of Division 16 - Electrical, and are indicated on the Electrical Drawings.
2. Where motor starters and disconnect switches for mechanical equipment are not indicated as work of Division 16 - Electrical, provide such starters and disconnect switches either integral with or mounted on said Mechanical Equipment and provided as work of this Division 15 - Mechanical.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. Central Plastics Co.
 2. Epcos Sales Inc.
 3. Hart Industries International, Inc.
 4. Watts Industries, Inc.; Water Products Div.
 5. Zurn Industries, Inc.; Wilkins Div.
 6. Or Approved Equal.
- B. Dielectric Unions:
 1. Central Plastics Co.
 2. Epcos Sales Inc.
 3. Hart Industries International, Inc.
 4. Watts Industries, Inc.; Water Products Div.
 5. Zurn Industries, Inc.; Wilkins Div.
 6. Or Approved Equal.
- C. Dielectric Flanges:
 1. Central Plastics Co.
 2. Epcos Sales Inc.
 3. Watts Industries, Inc.; Water Products Div.
 4. Or Approved Equal.
- D. Dielectric-Flange Insulating Kits:
 1. Calpico, Inc.
 2. Central Plastics Co.
 3. Or Approved Equal.
- E. Dielectric Couplings:
 1. Calpico, Inc.
 2. Lochinvar Corp.
 3. Or Approved Equal.
- F. Dielectric Nipples:
 1. Grinnell Corp.; Grinnell Supply Sales Co.
 2. Victaulic Co. of America.
 3. Or Approved Equal.

- G. Metal, Flexible Connectors:
 - 1. Flexicraft Industries.
 - 2. Flex-Weld, Inc.
 - 3. Grinnell Corp.; Grinnell Supply Sales Co.
 - 4. Mercer Rubber Co.
 - 5. Metraflex Co.
 - 6. Uniflex, Inc.
 - 7. Victaulic
 - 8. Or Approved Equal.

- H. Rubber, Flexible Connectors:
 - 1. General Rubber Corp.
 - 2. Mercer Rubber Co.
 - 3. Metraflex Co.
 - 4. Red Valve Co., Inc.
 - 5. Uniflex, Inc.
 - 6. Victaulic
 - 7. Or Approved Equal.

- I. Mechanical Sleeve Seals:
 - 1. Metraflex Co.
 - 2. Thunderline/Link-Seal.
 - 3. Or Approved Equal.

2.02 DIELECTRIC FITTINGS

- A. General: Assembly or fitting with insulating material isolating joined dissimilar metals, to prevent galvanic action and stop corrosion.
- B. Description: Combination of copper alloy and ferrous; threaded, solder, plain, and weld-neck end types and matching piping system materials.
- C. Insulating Material: Suitable for system fluid, pressure, and temperature.

2.03 FLEXIBLE CONNECTORS

- A. General: Fabricated from materials suitable for system fluid and that will provide flexible pipe connections. Include 125-psig (860-kPa) minimum working-pressure rating, unless higher working pressure is indicated, and ends according to the following:
- B. 2-Inch (51 mm) NPS (DN50) and Smaller: Threaded.
- C. 2-1/2-Inch (64mm) NPS (DN65) and Larger: Flanged.

2.04 MECHANICAL SLEEVE SEALS

- A. Description: Modular design, with interlocking rubber links shaped to continuously fill annular space between pipe and sleeve. Include connecting bolts and pressure plates.

2.05 FIRESTOPPING

- A. Provide firestopping against the spread of fire, smoke and gases where penetrations occur for piping and ductwork.

PART 3 EXECUTION

3.01 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. General: Install piping as described below, unless piping Sections specify otherwise. Individual Division 15 piping Sections specify unique piping installation requirements.
- B. Install pipe escutcheons for pipe penetrations of concrete and masonry walls, wall board partitions, and suspended ceilings according to the following:
- C. Chrome-Plated Piping: Cast brass, one piece, with set screw, and polished chrome-plated finish. Use split-casting escutcheons if required, for existing piping.
- D. Uninsulated Piping Wall Escutcheons: Cast brass or stamped steel, with set screw.
- E. Uninsulated Piping Floor Plates in Utility Areas: Cast-iron floor plates.
- F. Insulated Piping: Cast brass or stamped steel; with concealed hinge, spring clips, and chrome-plated finish.
- G. Piping in Utility Areas: Cast brass or stamped steel, with set screw or spring clips.

3.02 PAINTING AND FINISHING

- A. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.03 CUTTING AND PATCHING

- A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces necessary for mechanical installations. Perform cutting by skilled mechanics of trades involved.

3.04 GROUTING

- A. Install nonmetallic, non-shrink, grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors. Mix grout according to manufacturer's written instructions.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placing of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases to provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout according to manufacturer's written instructions.

END OF SECTION

SECTION 15060

SUPPORTS, ANCHORS, AND SEALS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: The work specified in this Section consists of support, anchors and seals for piping, ductwork and mechanical equipment.
- B. Related Sections:
 - 1. Division 15 Sections as Included.

1.02 REFERENCES

- A. American National Standards Institute (ANSI):
 - 1. ANSI B31.1, Code for Pressure Piping.
- B. American Society For Testing and Materials (ASTM):
 - 1. ASTM A 36; Specification for Structural Steel.
 - 2. ASTM A 47; Specification for Ferritic Malleable Iron Castings.
 - 3. ASTM A 48; Specification for Gray Iron Castings.
 - 4. ASTM A 53; Specification for Pipe, Steel, Black and Hot-Dipped Zinc-Coated Welded and Seamless.
 - 5. ASTM A 167; Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet and Strip.
 - 6. ASTM A 181; Specification for Forgings, Carbon Steel, for General-Purpose Piping.
 - 7. ASTM A 307; Specification for Carbon Steel Externally Threaded Standard Fasteners.
 - 8. ASTM A 320; Specification for Alloy Steel Bolting Materials for Low-Temperature Service.
 - 9. ASTM A 563; Specification for Carbon and Alloy Steel Nuts.
 - 10. ASTM A 576; Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality.
 - 11. ASTM B 695; Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel.
 - 12. ASTM D635; Test Method for Rate of Burning and/or extent and time of Burning of Self-Supporting Plastics in a Horizontal Position.
- C. American Welding Society (AWS): AWS D1.1 Structural Welding Code.

- D. Building Officials and Code Administrators International (BOCA):
 - 1. BOCA NBC 1993; National Building Code, 1993 Edition.
- E. Cast Iron Soil Pipe Institute, Cast Iron Soil Pipe and Fittings Handbook, CISPI Specifications HS-67 and 301.
- F. Federal Specifications (Fed. Spec.):
 - 1. Fed. Spec. FF-S-325, Shield, Expansion; Nail, Expansion and Nail Drive Screw (Devices, Anchoring, Masonry) Group II (Shield, Expansion Bolt Anchor) Type 4 (Wedge Expansion Anchors) Class 1 (One-Piece Steel Expander with Cone Taper Integral with Stud).
- G. Manufacturer's Standardization Society (MSS) of the Valve and Fittings Industry:
 - 1. MSS SP-58, Pipe Hangers and Supports - Materials, Design and Manufacturer.
 - 2. MSS SP-69, Pipe Hangers and Supports - Selection and Application.
- H. Sheet Metal and Air-Conditioning Contractors' National Association, Inc. (SMACNA):
 - 1. SMACNA HVAC Duct Construction Standards, Metal And Flexible.
 - 2. SMACNA Seismic Restraint Manual Guidelines for Mechanical Systems, 1991.
- I. National Fire Protection Association (NFPA):
- J. Underwriters' Laboratories, Inc. (UL) Listings and Labels shall govern the quality and performance of certain Products as specified herein.

1.03 SUBMITTALS

- A. Product Data: Submittals required for the following items:
 - 1. Pipe Supports.
 - 2. Duct Supports.
 - 3. Anchors and Fasteners.
 - 4. Sleeves and Seals.
 - 5. Insulation Shields
- B. Shop Drawings:
 - 1. Submit completely dimensioned shop drawings of piping layouts; indicating the type, design and location of pipe hangers, supports, anchors and guides required for piping installation.
 - 2. Submit completely dimensioned shop drawings of duct layouts indicating hanger and support locations.
 - 3. Submit completely dimensioned shop drawings of equipment suspension and support systems, including sizing of anchors and fasteners.

1.04 QUALITY ASSURANCE

- A. Design Criteria:
 - 1. Pipe Support Systems: Provide adequate pipe support systems designed in accordance with recognized engineering practices using, where possible, standard, commercially accepted pipe hangers and accessories.
 - a. Pipe hangers and supports shall conform to the latest requirements of ANSI B31.1, MSS SP-58, MSS SP-69, and other requirements specified herein.
 - 2. Duct Support Systems: Provide adequate duct suspension and support systems designed in accordance with SMACNA HVAC standards except for restrictions and other requirements as specified herein.
 - 3. Equipment Support Systems: Provide adequate equipment suspension systems and base supports designed in accordance with recognized engineering practices using, where possible, standard commercially accepted products and systems.
 - a. Design and size equipment suspension systems and base supports units based on installation instruction or information as obtained from equipment manufacturers and other requirements as specified herein.

- B. Anchor and Fastener Design Requirements:
 - 1. Sizing: Provide anchors and fasteners for Product installations of such diameters and lengths as recommended by the particular Product manufacturer involved.
 - a. When sizing recommendations are not obtainable, size fasteners in the largest diameter that will pass through boltholes as provided in the Products for anchoring and fastening purposes.
 - 2. Safety Factor: Determine the lengths of anchors and fasteners based on substrate materials at points of anchor installation and to provide a safety factor of four to one.

- C. Materials Compatibility: Where pipe supports contact bare piping or in-line devices, provide supports of compatible material so that neither will have a deteriorating action on the other.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Concrete Inserts: For upper attachments in cast-in-place concrete structures provide cast-in inserts made of carbon steel ASTM A 36 or malleable iron ASTM A 47.
 - 1. Where attached loads exceed the recommended load for an individual insert, provide multiple inserts with a trapeze type connecting member below the concrete.

- B. Beam Clamps: For upper attachments on structural steel provide beam clamps of carbon steel ASTM A 36 or forged steel ASTM A 181.
 - 1. Holes drilled in structural steel for hanger support rods will not be permitted.

2. Provide clamps with hardened steel cup-point set screw and lock-nut for anchoring in place.
 3. Base clamp size selection on required load being supported.
- C. Hanger Rods: Carbon steel conforming to ASTM A 576.
1. Diameter of rods for piping system support shall conform to ANSI B31.1.
 - a. In no case shall hanger rods less than 3/8-inch (9.5 mm) diameter be provided for support of pipe sizes two inches and smaller, or less than 1/2-inch (12.7 mm) diameter rod for supporting pipe sizes 2-1/2-inch (65 mm) and larger.
 2. Size hanger rods for duct work systems in accordance with SMACNA standards.
 3. Size hanger rods for mechanical equipment support based on installation instructions as obtained from equipment manufacturers.
- D. Auxiliary Steel: Provide auxiliary steel where support of piping systems and equipment is required between building structural elements. Provide light gauge and structural steel shapes conform to requirements of ASTM A 36.
1. Contractor shall have the option to use pre-engineered support systems of electrogalvanized steel products such as Kindorf, UniStrut or B-Line. MIXTURE OF SUPPORT SYSTEM MANUFACTURER'S PRODUCTS NOT PERMITTED.
 2. Where auxiliary steel is indicated as stainless steel, provide AISI Type 304 stainless steel conforming to ASTM A 167.
- E. Vibration Isolators: See Section 15065 Vibration Isolation.

2.02 PIPE SUPPORTS

- A. Base Supports: Where base supports are indicated for valves and pipe fittings provide saddles supported by pipe columns.
1. Saddles: Consisting of devices similar to ITT Grinnell Figure 258 Cast Iron Pipe Saddle Support; and pipe column designed to adequately support the applied loads with a steel base anchored to floor.
 2. Pipe Column: Pipe nipple of Schedule 80 galvanized steel pipe ASTM A 53.
 3. Riser Clamps: Support vertical runs of piping at each floor, or closer where required, with carbon steel clamps ASTM A 36 bolted around pipes and attached to the building construction.
 4. Provide copper plated clamps for copper tubing support.
 5. Provide two bolt type clamps designed for installation under insulation on insulated pipe runs.
- B. Offset Pipe Clamp: Where pipes are indicated as offset from wall surfaces, provide double-leg design two-piece pipe clamp similar to Figure 366 by Fee & Mason. Clamp material as indicated on the Drawings.
- C. Hangers: Fabricated of malleable iron ASTM A 47, or carbon steel ASTM A 36.

- D. Provide coated or plated hangers to isolate steel hangers from dissimilar metal tube or pipe.
 - 1. Hangers for pipe sizes 2-1/2-inches (65 mm) or larger shall incorporate a means of vertical adjustment after erection while supporting the load.
 - 2. Adjustable Band Hangers: Carbon steel band type hangers designed for suspension on hanger rods with provisions for vertical adjustments and locking in position using supporting and locknuts. Provide band hangers to support non-insulated pipe.
 - 3. Clevis Hangers for Non-Insulated Pipe: Carbon steel yoke and U-strap type with cross bolt over pipe.
 - 4. Clevis Hangers for Insulated Pipe: Carbon steel yoke and U-strap type hanger designed for installation under insulation with cross bolt outside the insulation.
 - 5. UL and NFPA Approved Hangers: Clevis type, adjustable swivel type, or adjustable flat-iron type. Where adjustable flat iron hangers cannot be used, hangers may be universal channel type or C-type with retaining strap.
- E. Brackets: Where piping is run adjacent to walls or steel columns, provide welded steel brackets ASTM A 36 and pre-punched with a minimum of two fastener holes.
- F. Racks: Multiple pipe racks or trapeze hangers fabricated from steel ASTM A 36, and designed to suit conditions at points of installation.
 - 1. Keep pipes in their relative positions to each other by the use of clamps or clips. Lines subject to thermal expansion must be free to slide or roll.

2.03 DUCT SUPPORTS

- A. Materials: Hanging and support system materials shall conform to the requirements of referenced SMACNA Standards specified under other Sections of the Specifications, but subject to the following limitations.
 - 1. Wire hangers in lieu of rod or strap hangers not acceptable.
 - 2. Provide hanging and support system in materials and finishes matching that of the ductwork.

2.04 ANCHORS AND FASTENERS

- A. Anchor Bolts (Pre-Set): Where anchor bolts are indicated or required as pre-set in cast-in-place concrete, provide anchor bolts of lug or bent shape design.
 - 1. Galvanized Bolts: ASTM A 307 for bolts, nuts and washers; and ASTM B 695 or A 153 for galvanizing.
 - 2. Stainless Steel Bolts: ASTM A 320, Grade B8, AISC Type 303 or 304.
- B. Drilled-In Expansion Anchors and Fasteners:
 - 1. Applications In Masonry (and Precast Concrete Hollow-Core Structural Elements):

- a. Anchors: Provide anchors designed to accept both machine bolts and/or threaded rods. Such anchors shall consist of an expansion shield and expander nut contained inside the shield. Expander nut fabricated and designed to climb the bolt or rod thread and simultaneously expand the shield as soon as the threaded item, while being tightened, reaches and bears against the shield bottom.
 - 1) Shield Body: Consisting of four legs, the inside of each tapered toward shield bottom (or nut end). The end of one leg is elongated and turned across shield bottom. Outer surface of shield body ribbed for grip-action.
 - 2) Expander Nut: Square design with sides tapered inward from bottom to top.
 - 3) Material: Die cast Zamac No. 3 zinc alloy of 43,000 psi (296474 Kpa) minimum tensile strength. Shield and nut made in conformance with S.A.E. 90 3 ASTM XI.
 - b. Fasteners: Machine bolts conforming to S.A.E. Grade 2, for use with above anchors; nuts and washers conforming to ASTM A 563.
 - c. Acceptable Manufacturers:
 - 1) U.S.E. Diamond, Inc.; FORWAY System.
 - 2) Or Approved Equal.
2. Applications in Cast-in-Place Concrete (and Solid Precast Concrete Structural Elements):
- a. Anchor/Fastener: UL Listed and one-piece stud (bolt) with integral expansion wedges, nut and washer, and meeting physical requirements of Fed. Spec. FF-S-325, Group II, Type 4, Class 1.
 - b. Stainless Steel Anchor/Fastener: UL Listed one-piece stud (bolt) with integral expansion wedges, nut and washer, and meeting physical requirements of Fed. Spec. FF-S-325, Group II, Type 4, Class 1. Stud of AISI Type 303 or 304 stainless and nut and washer of AISI Type 316 stainless.
 - c. Acceptable Manufacturers:
 - 1) U.S.E. Diamond, Inc.; SUP-R-STUD.
 - 2) Hilti Fastening Systems; KWIK-BOLT.
 - 3) Molly Fastener Group; PARABOLT.
 - 4) Phillips; RED HEAD Wedge-Anchor.
 - 5) Or Approved Equal.
3. Applications in Horizontal (Floor Mounted) for Adhesive Anchors: Composed of an anchor rod assembly and an anchor rod adhesive cartridge.
- a. Anchor Rod Assembly: Chamfered and threaded stud rod of ASTM A 307 steel with nut and washer of ASTM A 563 steel.
 - b. Stainless Steel Anchor Rod Assembly: Chamfered and threaded stud rod of AISI Type 304 stainless with nut and washer of AISI Type 316 stainless.
 - c. Adhesive Cartridge: Sealed capsule containing premeasured amounts of resin, quartz sand aggregate, and a hardener contained in a separate vial

within the capsule. Capsule ingredients activated by the insertion procedure of the anchor rod assembly.

- d. Acceptable Manufacturers:
 - 1) U.S.E. Diamond, Inc.; SUP-R-SET.
 - 2) Hilti Fastening Systems; HVA.
 - 3) Molly Fastener Group: PARABOND.
 - 4) Or Approved Equal.
 - 4. Note: Hammer drive-type and explosive charge drive-type anchors and fastener systems are acceptable. Plastic-inserts, fiber-inserts, and drilled-in plastic sleeve/nail drive systems are also acceptable.
- C. Welding Electrodes: Table 4.1.1 of AWS D1.1 as required for applicable base metals and welding process.

2.05 SLEEVES AND SEALS

- A. Pipe Sleeve Sizing:
- 1. Uninsulated Pipes: Size sleeves two pipe sizes larger than pipe passing through, or size sleeves for a minimum of 1/2-inch (12.7 mm) clearance between inside of sleeve and outside diameter of pipe passing through.
 - 2. Wall Seal Sleeve: Size sleeves to accommodate the pipe plus the hydrostatic Wall Seal.
 - 3. Insulated Pipes: Size sleeves for a minimum of 1/2-inch (12.7 mm) clearance between inside of sleeve and outside diameter of insulation covering on pipes passing through.
 - 4. Sleeve Length:
 - a. Wall and Partitions: Equal to total thickness of wall or partitions and terminated flush with finished surfaces.
 - b. Floors: Equal to total depth of floor construction including finish and extending a minimum of one inch above floor level.
- B. Sleeve Materials:
- 1. Pipe Sleeves In Cast-In-Place Concrete: Fabricate from Schedule 10 black steel pipe and weld a 2-inch (51 mm) wide intermediate anchoring flange of 3/16-inch (4.8 mm) steel midway on pipe sleeve; or provide sleeve as furnished by wall seal manufacturer.
 - 2. Pipe Sleeves in Masonry: No. 18 gauge galvanized sheet steel.
 - 3. Pipe Sleeves in Wallboard Partitions: No. 18 gauge galvanized sheet steel.
- C. Wall Pipe: Cast iron construction with an integral intermediate anchoring flange midway on the pipe exterior.
- 1. Wall pipe ends of type indicated on Drawings, and where not indicated, pipe end shall match that of adjoining pipe.
 - 2. Provide wall pipes similar to those manufactured by Clow Corporation, American Cast Iron Pipe Co., U.S. Pipe and Foundry Co., or approved equal.

- D. Foundation Sleeves: Gray or ductile cast iron with intermediate wall collar anchor and cutting grooves on the plain end.
 - 1. Sleeve designed for mechanical joint gasket and gland and furnished with such. Sleeve designed to pass pipes through interior dimension of sleeve.
 - 2. Provide sleeves similar to those manufactured by Clow Corporation, MJ Wall Sleeve F-1429, or approved equal.

- E. Seals and Plates:
 - 1. Wall Seal: Hydrostatic modular compression link seal designed to seal opening between pipes and a through structure opening. Provide Link-Seal by Thunderline Corp., or equal. Caulking, mastic sealants, lead/oakum, continuous (solid) gaskets are not acceptable as equal.
 - 2. Wall and Ceiling Plates: Cast metal with integral set screw or similar anchoring screw. Hinged or split design plates may be provided.
 - 3. Escutcheons: Provide chrome plated stamped steel hinged plates to close pipe penetrations through structure interior in finished areas. Provide plates designed to lock on pipes using setscrews.

PART 3 EXECUTION

3.01 PIPING SYSTEM SUPPORT INSTALLATION

- A. General:
 - 1. Install pipe supports and anchors to hold piping straight and true to line both vertically and horizontally.
 - 2. Where thermal movement in piping systems will occur, provide piping system supports capable of supporting the line in all operating conditions.
 - 3. The supporting force at each hanger shall prevent excessive stress in the pipe and connected equipment.
 - 4. Install pipe supports anchored directly to or suspended directly from structural supports. Where pipe hangers fall between structural members provide auxiliary steel supports to carry pipe hangers.
 - 5. Do not support piping from metal decks.

- B. Spacing of Hangers and Supports:
 - 1. General:
 - a. Space hangers and supports as stated herein and in ANSI B31.1, MSS SP 58 and SP 69.
 - b. Give special consideration to spacing of hangers and supports where components such as fittings and valves impose concentrated loads.
 - 2. Cast Iron Soil Pipe: Space hangers on horizontal runs of Cast Iron Soil Pipe according to CISPI 301.
 - 3. Steel Pipe: Space hangers on horizontal runs of steel pipe as follows:
 - a. Pipe sizes 1-inch (25mm) and smaller - 8 ft. (2.4M) O.C. maximum.

- b. Pipe sizes 1-1/4-inches to 2-inches (32-50 mm) - 10 ft. (3 m) O.C. maximum.
 - c. Pipe sizes 2-1/2-inches (65 mm) and larger - 12 ft. (3.7 M)O.C. maximum.
 - 4. Copper Tubing: Space hangers on horizontal runs of copper tubing as follows:
 - a. Tube sizes 3/8 through 3/4-inches (9 through 19 mm) - 5 ft. (1.5 M) O.C. maximum.
 - b. Tube size one inch (25 mm) - 6 ft. (1.8 M) O.C. maximum.
 - c. Tube size 1 1/4-inches (32 mm) - 7 ft. (2.1 M) O.C. maximum.
 - d. Tube size 1 1/2 through 2-inches (40 through 50 mm) - 8 ft. (2.4 M) O.C. maximum.
 - C. Plastic Piping: Provide hangers at locations and spacing limitations in accordance with pipe manufacturer's installation specifications.
 - D. Pipe Sleeve Installation:
 - 1. Set pipe sleeves in concrete formwork, walls, partitions, floors and ceilings as construction work progresses. Provide sleeve for each pipe individually.
 - 2. Provide and set sleeves to avoid delaying construction activities of other trades. Perform any additional cutting and boring required due to improperly located or omitted openings without cost to the ROICC and perform such additional work under the observation of the COR.
 - E. Equipment Supports and Penetrations Seals for Materials and Equipment Exposed to Weather: Provide stainless steel fasteners for both exposed and concealed attachments in exterior locations.
 - F. Seals and Plates Installation:
 - 1. Following pipe installation through sleeves in exterior walls below grade, install Wall Seal to render installation leak free. Wall Seal not required in interior walls, partitions, floor and ceilings.
 - 2. Install wall seal as close to outside surface of wall as possible to provide a watertight seal below grade. Apply a coating of coal tar paint or other type approved coating on bolt heads and other metal parts on below grade wall seals prior to backfilling.
 - 3. Install wall and ceiling plates to close pipe sleeve openings.
 - 4. Install escutcheons to close pipe sleeve openings in finished areas.
 - G. Wall Pipe Installations:
 - 1. Provide wall pipes for those installations indicated on the Drawings where piping is cast integrally into the structure.
 - 2. Provide wall pipes with joining ends as match or mate with those of pipes being connected.
 - 3. Provide the proper gaskets, bolts, nuts and washers as required in the pipe joining to wall pipes.
 - H. Foundation Sleeve Installation:

1. Provide foundation sleeves for those piping installations where piping is designed to pass through a foundation wall and does not form an integral part of the wall.
2. Provide the proper gland and gasket to make a water tight seal on piping passing through the foundation sleeve.

3.02 DUCT SUPPORT INSTALLATION

- A. General: Install duct hanging and support systems in conformance with requirements of referenced SMACNA Standards specified under other Sections of the Specifications, but subject to the following limitations.
1. Use upper attachments and anchors and fasteners as specified herein.
 2. Do not support ductwork from metal decks.

3.03 ANCHOR AND FASTENER INSTALLATIONS

- A. Auxiliary Steel Fabrication: Insofar as possible, fit and shop assemble steel fabrications and make ready for field installation.
1. Drill or punch holes as required for attachment of work and for bolted connections. Burned holes are not acceptable.
 2. Perform welding of assemblies in accordance with AWS D1.1. Dress welds smooth and free of sharp edges and corners.
 3. Perform shop painting of auxiliary steel as specified in Section 15050.
- B. Threaded Bolts: Draw threaded bolted connections up tight using lock washers to prevent bolt or nut loosening.
- C. Drilled-In Expansion Anchor and Fastener Installation:
1. General: In general, install expansion anchors in strict accordance with manufacturer's instructions and in accordance with the following.
 2. Drilling Holes: Use rotary hammer type drill and make drill holes to the required diameter and depth as consistent with anchor manufacturer's instructions for size of anchors being installed.
 3. Minimum Embedment: Embed expansion anchors to four and one-half bolt diameters, unless otherwise indicated on Drawings.
- D. Drilled-In Adhesive Anchor Installation:
1. General: In general, install adhesive anchors in strict accordance with manufacturer's instructions and in accordance with the following.
 2. Drilling Holes: Use rotary hammer type drill and make drill holes to the required diameter and depth as consistent with anchor manufacturer's instructions for size of anchors being installed.
 - a. Prior to setting cartridge and anchor stud clean drilled holes free of loose material by vacuum process, finishing with a blast of compressed air, and cover hole until actual use.

3. Anchor Rod Installation: Following cartridge installation in prepared drill holes, set anchor rod to the required depth. Set anchor rods truly perpendicular (normal) to the base plate of item being anchored.

4. Minimum Embedment Table:

Adhesive Anchor

Diameter

Embedment Depth

3/8 in.(9.5mm)

3 1/2 in.(88.9 mm)

1/2 in.(12.7 mm)

4 1/4 in. (107.95 mm)

5/8 in.(15.9 mm)

5 in. (127 mm)

3/4 in.(19.1mm)

6-5/8 in.(168.3 mm)

7/8 in.(22.2 mm)

6-5/8 in.(168.3 mm)

1 in.(25.4 mm)

8 1/4 in. (210 mm)

E. Explosive charge drive-type anchors and fasteners

END OF SECTION

SECTION 15065

VIBRATION ISOLATION

PART 1 GENERAL

1.01 DESCRIPTION

- A. Furnish and install vibration control devices, materials, and related items. Perform all work as shown on the drawings and as specified herein to provide complete vibration isolation systems in proper working order.

1.02 MATERIAL AND EQUIPMENT

- A. Vibration isolation mounts shall be supplied by one of the following approved manufacturers:
 - 1. Amber/Booth Co. (Houston, TX) A.B.
 - 2. Mason Industries, Inc. (Hauppauge, NY) M.I.
 - 3. Kinetics Noise Control, Inc. (Dublin, OH) K.N.C.
 - 4. Vibration Eliminator Co., Inc. (Long Island City, NY) V.E.
 - 5. Vibration Mountings & Controls, Inc. (Butler, NJ) V.M.&C.
 - 6. Or Approved Equal.
- B. Unless otherwise specified, supply only new equipment, parts and materials.
- C. Unless otherwise approved by the Contracting Officer, field-installed vibration isolation equipment shall be furnished by a single manufacturer or his authorized representative, who shall also be responsible for all work specified in this section to be performed by the manufacturer.

1.03 QUALITY ASSURANCE

- A. Coordinate the size, location, and special requirements of vibration isolation equipment and systems with other trades. Coordinate plan dimensions with size of housekeeping pads.
- B. Provide vibration isolators of the appropriate sizes, with the proper loading to meet the specified deflection requirements.
- C. Furnish and install any incidental materials such as mounting brackets, attachments and other accessories as may be needed to meet the requirements stated herein, even if not expressly specified or shown on the drawings, without claim for additional payment.
- D. Verify correctness of equipment model numbers and conformance of each component with manufacturer's specifications.

- E. Should any rotating equipment cause excessive noise or vibration when properly installed on the specified isolators, the Contractor shall be responsible for rebalancing, realignment, or other remedial work required to reduce noise and vibration levels. Excessive is defined as exceeding the manufacturer's specifications for the unit in question.
- F. Upon completion of the work, the Contracting Officer's Representative (COR) shall inspect the installation and shall inform the installing contractor of any further work that must be completed. Make all adjustments as directed by the COR that result from the final inspection. This work shall be done before vibration isolation systems are accepted.

1.04 SUBMITTALS

- A. Submit shop drawings of the items listed below.
 - 1. A complete description of products to be supplied, including product data, dimensions, specifications, and installation instructions.
 - 2. Detailed selection data for each vibration isolator supporting equipment, including:
 - a. The equipment identification mark;
 - b. The isolator type;
 - c. The actual load;
 - d. The static deflection expected under the actual load;
 - e. The specified minimum static deflection.
 - 3. Steel rails, steel base frames, and concrete inertia bases showing all steel work, reinforcing, vibration isolator mounting attachment method, and location of equipment attachment bolts.
 - 4. Special details necessary to convey complete understanding of the work to be performed.

1.05 DESIGN REQUIREMENTS

- A. Design isolators for equipment installed outdoors to provide adequate restraint to withstand the force of a 100 mph (161 KPH) wind applied to any exposed surface of the isolated equipment. Isolators for outdoor equipment shall have bolt holes for attachment to equipment and to supports. The vibration isolation Vendor shall submit verifying shear and over turning calculations, for their product and equipment installation arrangement, stamped by a licensed Professional Engineer. The design and supply of miscellaneous support steel above and below isolators will not be the responsibility of the vibration isolation manufacturer.

PART 2 PRODUCTS

2.01 VIBRATION ISOLATOR TYPES

A. General

1. All metal parts installed out-of-doors shall be corrosion resistant after fabrication. Galvanizing shall meet ASTM Salt Spray Test Standards and Federal Test Standard No. 14.
2. Isolators installed out-of-doors shall have base plates with bolt holes for fastening the isolators to the support members.
3. Isolator types are scheduled to establish minimum standards. At the Contractor's option, labor-saving accessories can be an integral part of isolators supplied to provide initial lift of equipment to operating height, hold piping at fixed elevations during installation and initial system filling operations, and similar installation advantages. Accessories and seismic restraint features must not degrade the isolation performance of the isolators.
4. Static deflection of isolators shall be as provided in the EXECUTION section. All static deflections stated are the minimum acceptable deflection for the mounts under actual load. Isolators selected solely on the basis of rated deflections are not acceptable and will be disapproved.

B. Type FSN (Floor Spring and Neoprene)

1. FSN isolators shall be freestanding and laterally stable without any housing. Spring diameter shall be not less than 0.8 of the compressed height of the spring at the rated load. Springs shall have a minimum additional travel-to-solid equal to 50% of the rated deflection. Springs shall be so designed that the ratio of horizontal stiffness to vertical stiffness is approximately 1 (one). Mounts shall have leveling bolts.
2. The spring element in the isolator shall be set in a neoprene cup and have a steel washer or a flat surface in contact with the neoprene to distribute the load evenly over the bearing surface of the neoprene. Alternatively, each isolator shall be mounted on a Type NP isolator. If the NP isolator is used, a rectangular bearing plate of appropriate size shall be provided to load the pad uniformly within the manufacturer's recommended range. If the isolator is to be fastened to the building and the NP isolator is used, the holes in the isolator base plate shall be oversized and grommets shall be provided for each base plate bolt hole.
3. If the basic spring isolator has a neoprene friction pad on its base and an NP isolator is to be added to the base, a galvanized steel, stainless steel or aluminum bearing plate shall be used between the friction pad and the NP isolator. If the isolator is outdoors, bearing plates shall not be made of galvanized steel. The NP isolator, bearing plate and friction pad shall be permanently adhered to one another and to the bottom of the isolator base plate.

4. Type FSN isolators shall be one of the following products with the appropriate neoprene pad (if used) selected from Type NP or approved equal:
 - a. Type SW A.B.
 - b. Type SLF M.I.
 - c. Type FDS K.N.C.
 - d. Type OST V.E.
 - e. Series AC V.M.&C.

C. Type FSNTL (Floor Spring and Neoprene Travel Limited)

1. FSNTL isolators shall be freestanding and laterally stable without any housing. Spring diameter shall be not less than 0.8 of the compressed height of the spring at the rated load. Spring shall have a minimum additional travel-to-solid equal to 50% of the rated deflection. Springs shall be so designed that the ratio of horizontal stiffness to vertical stiffness is approximately 1 (one). Mounts shall have leveling bolts. Mounts shall have vertical travel limit stops to control extension when weight is removed. The travel limit stops shall be capable of serving as blocking during erection of the equipment. A minimum clearance of 1/4" shall be maintained around restraining bolts and between the limit stops and the spring to avoid interference with the spring action.
2. The spring element in the isolator shall be set in a neoprene cup and have a steel washer or a flat surface in contact with the neoprene to distribute the load evenly over the bearing surface of the neoprene. Alternatively, each isolator shall be mounted on a Type NP isolator. If the NP isolator is used, a rectangular bearing plate of appropriate size shall be provided to load the pad uniformly within the manufacturer's recommended range. If the isolator is to be fastened to the building and the NP isolator is used, the holes in the isolator base plate shall be oversized and GROMMETS shall be provided for each base plate bolt hole.
3. If the basic spring isolator has a neoprene friction pad on its base and an NP isolator is to be added to the base, a galvanized steel, stainless steel or aluminum bearing plate shall be used between the friction pad and the NP isolator. If the isolator is outdoors, bearing plates shall not be made of galvanized steel. The NP isolator, bearing plate and friction pad shall be permanently adhered to one another and to the bottom of the isolator base plate.
4. Type FSNTL isolators shall be one of the following products, with the appropriate neoprene pad (if used) selected from Type NP or approved equal:
 - a. Type CT A.B.
 - b. Type SLR M.I.
 - c. Type FLS K.N.C.
 - d. Type KW V.E.
 - e. Series AWR V.M.&C.

D. Type FN (Floor Neoprene)

1. NP isolators shall be neoprene-in-shear type with steel reinforced top and base. All metal surfaces shall be covered with neoprene. The top and bottom surfaces shall be ribbed. Bolt holes shall be provided in the base and the top shall have a threaded fastener. The mounts shall include leveling bolts that may be rigidly connected to the equipment.

2. Type FN isolators shall be one of the following products or approved equal:
 - a. Type RVD A.B.
 - b. Type ND M.I.
 - c. Type RD K.N.C.
 - d. Type D44 V.E.
 - e. Series RD V.M.&C.

E. Type NP (Neoprene Pad)

1. NP isolators shall be one layer of 5/16" (7.9 mm) to 3/8" (9.5 mm) thick ribbed or waffled neoprene. The pads shall be sized so that they will be loaded within the manufacturer's recommended range.
2. Type NP isolators shall be one of the following products or approved equal:
 - a. Type NR A.B.
 - b. Type W M.I.
 - c. Type NPS K.N.C.
 - d. Type 200N V.E.
 - e. Series Maxi-Flex V.M.&C.

F. Type HSN (Hanger Spring and Neoprene)

1. HSN isolators shall consist of a freestanding and laterally stable steel spring and a neoprene element in series, contained within a steel housing. Spring diameters and hanger housing lower hole sizes shall be large enough to permit the hanger rod to swing through a 30° arc before contacting the housing. Alternatively, other provisions shall be made to allow for a 30° arc of movement of the bottom hanger rod without contacting the isolator housing. Spring diameter shall be not less than 0.8 of the compressed height of the spring at the rated load. Spring elements shall have a minimum additional travel-to-solid equal to 50% of the rated deflection. The neoprene element shall be designed to have a 0.3" minimum static deflection. The deflection of both the spring element and the neoprene element shall be included in determining the overall deflection of Type HSN isolators.
2. A precompressed glass fiber element may be substituted for the neoprene element.
3. Type HSN isolators shall be one of the following products or approved equal:
 - a. Type BSR-A A.B.
 - b. Type 30N M.I.
 - c. Type SRH or SFH K.N.C.
 - d. Type SNRC V.E.
 - e. Type RSH 30A or RSHSC V.M.&C.

G. Type HN (Hanger Neoprene)

1. HN isolators shall consist of a neoprene-in-shear element contained within a steel housing. A neoprene neck bushing shall be provided where the hanger rod passes through the hanger housing to prevent the rod from contacting the hanger housing.
2. A precompressed glass fiber element may be substituted for the neoprene element.

3. Type HN isolators shall be one of the following products or approved equal:
 - a. Type BRD-A A.B.
 - b. Type HD M.I.
 - c. Type RH or FH K.N.C.
 - d. Type 3C V.E.
 - e. Type RHD V.M.&C.

2.02 EQUIPMENT BASES

- A. Type BIB (Base - Inertia Base)
 1. Inertia bases shall be formed of stone-aggregate concrete (150 lb./cu.ft. (2403 Kg/cu. m.)) and appropriate steel reinforcing cast between welded or bolted perimeter structural steel channels. Inertia bases shall be built to form a rigid base that will not twist, rack, deform, deflect, or crack in any manner that would negatively affect the supported equipment or the vibration isolation mounts. Inertia bases shall be adequately sized to support basic equipment units and motors plus any associated pipe elbow supports, duct elbow supports, electrical control elements, or other components closely related and requiring resilient support in order to prevent vibration transfer to the building structure. Inertia base depth shall be at least 1/12 the longest dimension of the base supported between isolators and not less than 6"(152.4 mm). The base footprint shall be large enough to provide stability for supported equipment. Inertia bases shall include side mounting brackets for attachment to vibration isolators. Mounting brackets shall be located on the sides of the base that are parallel to the axis of rotation of the supported equipment. Concrete may be provided by the General Contractor.
 2. Frame and reinforcement for Type BIB bases shall be one of the following products or approved equal:
 - a. Type CPF A.B.
 - b. Type KSL or BMK M.I.
 - c. Type CIB-L or CIB-H K. N.C.
 - d. Type SN V.E.
 - e. Series MPF or WPF V.M.&C.

2.03 RESILIENT PENETRATION SLEEVE/SEAL

- A. Resilient penetration sleeve/seals shall be field-fabricated from a pipe or sheet metal section that is 1/2" to 3/4" (12.7 to 19 mm) larger than the penetrating element in all directions around the element, and shall be used to provide a sleeve through the construction penetrated. The sleeve shall extend 1" (25.4mm) beyond the penetrated construction on each side. The space between the sleeve and the penetrating element shall be packed with glass fiber or mineral wool to within 1/4" (6.4 mm) of the ends of the sleeve. The remaining 1/4" (6.4 mm) space on each end shall be filled with acoustical sealant to form an airtight seal. The penetrating element shall be able to pass through the sleeve without contacting the sleeve. Alternatively, prefabricated sleeves accomplishing the same result are acceptable.

2.04 RESILIENT LATERAL SUPPORTS

- A. These units shall either be a standard product of the vibration isolator manufacturer, or be custom fabricated from standard components. These units shall incorporate neoprene isolation elements similar to Type FN that are specifically designed to provide resilient lateral bracing of ducts or pipes.
- B. Resilient lateral supports shall be one of the following products or approved equal:
 - 1. Type Custom A.B.
 - 2. Type ADA M.I.
 - 3. Type RGN K.N.C.
 - 4. Type VERG or VPL V.E.
 - 5. Type MDPA V.M.&C.

2.05 FLEXIBLE DUCT CONNECTIONS

- A. Flexible duct connections shall be made from rubber-coated fabric. The clear space between connected parts shall be a minimum of 3" (76.2 mm) and the connection shall have a minimum of 1.5" (38.1 mm) of slack material.

2.06 FLEXIBLE PIPE CONNECTIONS

- A. Flexible pipe connections shall be corrugated, stainless steel liner tubing covered with stainless steel wire
- B. The flexible connections shall be selected and specially fitted, if necessary, to suit the system temperature, pressure, and fluid type. In addition, suitable flexible connections should be selected, if possible, which do not require rods or cables to control extension of the connector.
- C. Connectors for pipe sizes 2" (50.8 mm) or smaller shall have threaded female union couplings on each end. Larger sizes shall be fitted with metallic flange couplings.

2.07 THRUST RESTRAINTS

- A. Thrust restraints shall consist of a spring element in series with a neoprene pad. The unit shall be designed to have the same deflection due to thrust-generated loads as specified for the isolators supporting the equipment. The spring element shall be contained within a steel frame and be designed so it can be precompressed at the factory to allow for a maximum of 1/4" (6.4 mm) movement during starting or stopping of the equipment. Allowable movement shall be field-adjustable. The assembly shall be furnished complete with rods and angle brackets for attachment to both the equipment and the adjacent fixed structural anchor. The thrust restraints shall be installed on the discharge of the fan so that the restraint rods are in tension. Assemblies that place the rods in compression are not acceptable. The holes in the spring restraint brackets through which the restraint rods pass must be oversized to prevent contact between the brackets and rods.

- B. Thrust restraints shall be one of the following products or an approved equal:
 - 1. Type TRK A.B.
 - 2. Type HSR K.N.C.
 - 3. Type WB M.I.
 - 4. Thrust Restraint V.E.

2.08 GROMMETS

- A. Grommets shall be made of neoprene or neoprene impregnated duck that is specially formed to prevent bolts from directly contacting the isolator base plate, and shall be sized so that they will be loaded within the manufacturer's recommended load range.
- B. Grommets shall either be custom made by combining a neoprene washer and sleeve, or be one of the following products or an approved equal:
 - 1. Type Isogrommets MBIS, Inc. (Bedford Heights, OH)
 - 2. Type WB Barry Controls (Brighton, MA)
 - 3. Type HG Mason Industries Inc. (Hauppauge, NY)

2.09 ACOUSTICAL SEALANT

- A. Sealants for acoustical purposes as described in this specification shall be silicone or one of the resilient, nonhardening sealants and be amine-free as indicated below:
 - 1. Acoustical sealant D.A.P.
 - 2. BR-96 or AC-20 (AC-20 FTR - Fire Rated) Pecora
 - 3. Sonoloc Sanborn
 - 4. Acoustical Sealant #834 (Acrylic Latex) Tremco
 - 5. Acoustical sealant U.S.G.

PART 3 EXECUTION

3.01 APPLICATION

- A. General
 - 1. Refer to the PRODUCTS section of this specification for vibration isolation devices identified on the drawings or specified herein.
 - 2. The static deflection of all isolators specified herein are the minimum acceptable deflections for the mounts under actual load. Isolators selected solely on the basis of rated deflection are not acceptable and will be disapproved.
- B. Major Equipment Isolation
 - 1. Unless otherwise shown or specified, all floor-mounted major equipment shall be set on housekeeping pads.
 - 2. Types and minimum static deflections of vibration isolation devices for major equipment items shall be as specified hereunder.
 - 3. Flexible duct connections shall be installed at all fan unit intakes, fan unit discharges, and wherever else shown on the drawings.

4. Flexible pipe connections shall be installed at all pipe connections to vibration-isolated equipment in the positions shown on the drawings per par. 3.03 of this section.
5. Electrical connections to vibration-isolated equipment shall be flexible, as called for in the electrical portion of the specification.

C. Miscellaneous Mechanical Equipment Isolation

1. Miscellaneous pieces of mechanical equipment, such as converters, pressure reducing stations, dryers, strainers, storage tanks, condensate receiver tanks, and expansion tanks, which are connected to isolated piping systems, shall be vibration-isolated from the building structure by Type NP or Type HN isolators (selected for 0.1" (2.54mm) static deflection), unless their position in the piping system requires a higher degree of isolation as called for under Pipe Isolation.

D. Pipe Isolation

1. All chilled water, hot water, steam, and drain piping that is connected to vibration-isolated equipment shall be isolated from the building structure within the following limits:
2. Within mechanical rooms;
3. Within 50-foot (15.2 M) total pipe length of connected vibration-isolated equipment (chillers, pumps, air handling units, pressure reducing stations, etc.);
4. At every support point for piping that is greater than 4 inches (101.6 mm) in diameter.
5. Piping shall be isolated from the building structure by means of vibration isolators, resilient lateral supports, and resilient penetration sleeve/seals.
6. Isolators for the first three support points adjacent to connected equipment shall achieve one half the specified static deflection of the isolators supporting the connected equipment. When the required static deflection of these isolators is greater than 1/2" (12.7 mm), Type FSN or HSN isolators shall be used. When the required static deflection is less than or equal to 1/2"(12.7 mm), Type FN or HN isolators shall be used. All other pipe support isolators within the specified limits shall be either Type FN or HN achieving at least 1/4" (6.4 mm) static deflection.
7. Where lateral support of pipes is required within the specified limits, this shall be accomplished by use of resilient lateral supports.
8. Pipes within the specified limits that penetrate the building construction shall be isolated from the building structure by use of resilient penetration sleeve/seals.
9. Provide flexible pipe connections as called for under Major Equipment above and wherever shown on the drawings.

E. Duct Isolation

1. All sheet metal ducts and air plenums that are within mechanical rooms or within a distance of 50' (15.2 M) total duct length of connected vibration-isolated equipment (whichever is longer) shall be isolated from the building structure by Type FN, PCF or HN isolators. All isolators shall achieve 0.1" (2.54 mm) minimum static deflection.
2. Ducts within the specified limits that penetrate the building construction shall be isolated from the building structure by use of resilient penetration sleeve/seals.

3. Flexible duct connections shall be provided as called for above under Major Equipment and wherever shown on the drawings.

3.02 INSTALLATION OF VIBRATION ISOLATION EQUIPMENT

A. General

1. Locations of all vibration isolation devices shall be selected for ease of inspection and adjustment as well as for proper operation.
2. Installation of vibration isolation equipment shall be in accordance with the manufacturer's instructions.

B. Isolators

1. All vibration isolators shall be aligned squarely above or below mounting points of the supported equipment.
2. Isolators for equipment with bases shall be located on the sides of the bases which are parallel to the equipment shaft unless this is not possible because of physical constraints.
3. Locate isolators to provide stable support for equipment, without excess rocking. Consideration shall be given to the location of the center of gravity of the system and the location and spacing of the isolators. If necessary, a base with suitable footprint shall be provided to maintain stability of supported equipment, whether or not such a base is specifically called for herein.
4. If a housekeeping pad is provided, the isolators shall bear on the housekeeping pad and the isolator base plates shall rest entirely on the pad.
5. Hanger rods for vibration-isolated support shall be connected to major structural members, not the floor slab between major structural members. Provide suitable intermediate support members as necessary.
6. Vibration isolation hanger elements shall be positioned as high as possible in the hanger rod assembly, but not in contact with the building structure, and so that the hanger housing may rotate a full 360° about the rod axis without contacting any object.
7. Parallel running pipes may be hung together on a trapeze that is isolated from the building. Isolator deflections must be the greatest required by the provisions for pipe isolation for any single pipe on the trapeze. Do not mix isolated and unisolated pipes on the same trapeze.
8. Pipes, ducts and equipment shall not be supported from other pipes, ducts and equipment.
9. Resiliently isolated pipes, ducts and equipment shall not come in rigid contact with the building construction or rigidly supported equipment.
10. The installed and operating heights of equipment supported by Type FSNTL isolators shall be identical. Limit stops shall be out of contact during normal operation. Adjust isolators to provide 1/4" (6.4 mm) clearance between the limit stop brackets and the isolator top plate, and between the travel limit nuts and travel limit brackets.
11. Adjust all leveling bolts and hanger rod bolts so that the isolated equipment is level and in proper alignment with connecting ducts or pipes.

C. Bases

1. No equipment unit shall bear directly on vibration isolators unless its own frame is suitably rigid to span between isolators and such direct support is approved by the equipment manufacturer. This provision shall apply whether or not a base frame is called for on the schedule. In the case that a base frame is required for the unit because of the equipment manufacturer's requirements and is not specifically called for on the equipment schedule, a base frame recommended by the equipment manufacturer shall be provided at no additional expense.
2. Unless otherwise indicated, there is to be a minimum operating clearance of 1" (25.4 mm) between steel rails, steel frame bases or inertia bases and the floor beneath the equipment. The isolator mounting brackets shall be positioned and the isolators adjusted so that the required clearance is maintained. The clearance space shall be checked by the Contractor to ensure that no construction debris has been left to short circuit or restrict the proper operation of the vibration isolation system.
3. Isolation bases shall be installed in strict accordance with the manufacturer's instructions.

D. Flexible Duct Connections

1. Prior to installation of the flexible connection, sheet metal ducts and plenum openings shall be squarely aligned with the fan discharge, fan intake, or adjacent duct section, and the gap between connected parts shall be uniform. Flexible duct connections shall not be installed until this provision is met. There shall be no metal-to-metal contact between connected sections, and the fabric shall not be stretched taut.

E. Flexible Pipe Connections

1. Install flexible pipe connections in strict accordance with the manufacturer's instructions.

F. Thrust Restraints

1. Thrust restraints shall be attached on each side of the fan parallel to the thrust force. This may require custom brackets or standoffs. The body of the thrust restraint shall not come in contact with the connected elements. Thrust restraints shall be adjusted to constrain equipment movement to the specified limit.

G. Grommets

1. Where grommets are required at hold down bolts of isolators, bolt holes shall be properly sized to allow for grommets. The hold down bolt assembly shall include washers to distribute load evenly over the grommets. Bolts and washers shall be galvanized.

H. Resilient Penetration Sleeve/Seals

1. Maintain an airtight seal around the penetrating element and prevent rigid contact between the penetrating element and the building structure. Fit the sleeve tightly to the building construction and seal airtight on both sides of the construction penetrated with acoustical sealant.

3.03 VIBRATION ISOLATION SCHEDULE FOR MAJOR EQUIPMENT

Equipment	Isolation Type	Min. Deflection
Air Handling Units	Internal Isolation by Unit Manufacturer	2.0-inches (63.5mm)
Centrifugal Fans	FSN	1.5-inches (38mm)

END OF SECTION

SECTION 15075

MECHANICAL IDENTIFICATION

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: The work specified in this Section consists of identification of mechanical systems and equipment.

1.02 REFERENCES

- A. ASME A13.1 - Scheme for the Identification of Piping Systems; The American Society of Mechanical Engineers; 1996 (ANSI/ASME A13.1).

1.03 SYSTEM DESCRIPTION

- A. Color Coding and Nomenclature for Building Piping: Conform to ASME A13.1.

1.04 SUBMITTALS

- A. List: Submit list of wording, symbols, letter size, and color-coding for mechanical identification.
- B. Chart and Schedule: Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
- C. Product Data: Provide manufacturers catalog literature for each product required.
- D. Manufacturer's Installation Instructions: Indicate special procedures, and installation.
- E. Project Record Documents: Record actual locations of tagged valves.

PART 2 PRODUCTS

2.01 PIPE IDENTIFICATION AND VALVE MARKING MATERIALS

- A. Pipe System Identification (Indoor Use): Provide a color-coded system of pipe identification in accordance with ANSI Standard A13.1. Wording and arrows shall be the same color. Background color shall coordinate with color referenced in Piping System Specifications. Pipe marker must indicate direction flow arrow and identify fluid being conveyed.
 - 1. Acceptable Manufacturers:
 - a. Seton Identification Products; Setmarks
 - b. Brady Corporation
 - c. Or Approved Equal.
 - 2. Tape pipe markers, flexible vinyl film tape with pressure sensitive adhesive backing and printed markings.

- a. Acceptable Manufacturers:
 - 1) Seton Identification Products; Opticode
 - 2) Brady Corporation
 - 3) Or Approved Equal.
- 3. Stenciling

2.02 VALVE IDENTIFICATION TAGS:

- A. 1 ½-inch (38.1 mm) diameter 19 gauge brass engravable tag. Provide brass “S” hook and brass jack chain with adjustable open and close links.
- B. Acceptable Manufacturers:
 - 1. Seton Identification Products; Style M5141
 - 2. Brady Corporation
 - 3. Or Approved Equal.

2.03 NAMEPLATES

- A. Description: Laminated three-layer plastic beveled edges, predrilled mounting holes, sheet metal screws or pressure sensitive adhesive backing, red background with white letters, size based on equipment description, treated for outdoor use.
- B. Manufacturers:
 - 1. Seton Identification Products; Seton Flex
 - 2. Brady Corporation
 - 3. Or Approved Equal.

2.04 DUCT MARKERS

- A. Stenciling
- B. Nomenclature: Include the following:
 - 1. Direction of airflow.
 - 2. Duct service.
 - 3. Duct origin.
 - 4. Duct destination.

2.05 CEILING TACKS

- A. Description: Steel with ¾-inch (20 mm) diameter color-coded head.
- B. Color code as follows:
 - 1. Yellow - HVAC equipment
 - 2. Red - Fire dampers/smoke dampers
 - 3. Green - Plumbing valves
 - 4. Blue - Heating/cooling valves
 - 5. Orange - Sprinkler Valves

2.06 VALVE CHART

- A. Frame with plastic window sized to accommodate chart, neatly type chart with valve number, use and location.
- B. Acceptable Manufacturers:
 - 1. Seton Identification; Style No. 37387
 - 2. Brady Corporation
 - 3. Or Approved Equal

PART 3 EXECUTION

3.01 PREPARATION

- A. Degrease and clean surfaces to receive identification materials.

3.02 INSTALLATION

- A. Install pipe markers in accordance with accepted shop drawings and manufacturer's instructions.
- B. Install valve tags in accordance with accepted shop drawings and manufacturer's instructions.
- C. Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
- D. Install tags with corrosion resistant chain.
- E. Install pipe markers in accordance with manufacturer's instructions.
- F. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.
- G. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.
- H. Identify air handling units, with plastic nameplates.
- I. Identify control panels and major control components outside panels with plastic nameplates.
- J. Identify thermostats relating to terminal boxes or valves with nameplates.
- K. Identify valves in main and branch piping with tags.
- L. Identify air terminal units with numbered tags.
- M. Tag automatic controls, instruments, and relays. Key to control schematic.

- N. Identify piping, concealed or exposed, with vinyl or stencil pipe markers. Use tags on piping 3/4 inch (19.1 mm) diameter and smaller. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 20 feet ((6.1 M) on straight runs including risers and drops, adjacent to each valve and Tee.
- O. Identify ductwork with plastic nameplates. Identify with air handling unit identification number and area served. Locate identification at air handling unit, at each side of penetration of structure or enclosure, and at each obstruction.
- P. Provide ceiling tacks to locate valves or dampers above T-bar type panel ceilings. Locate in corner of panel closest to equipment.

END OF SECTION

SECTION 15080

MECHANICAL INSULATION

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: The work specified in this Section consists of the various insulation systems required in the project.
- B. Related Sections:
 - 1. Basic Mechanical Materials and Methods: Section 15050.

1.02 REFERENCES

- A. American Society for Testing and Materials (ASTM):
 - 1. ASTM C 177; Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Grounded-Hot-Plate Apparatus.
 - 2. ASTM C 335; Test Method for Steady-State Heat Transfer Properties of Horizontal Pipe Insulation.
 - 3. ASTM C 518; Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
 - 4. ASTM C 534; Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
 - 5. ASTM C 547; Specification for Mineral Fiber Preformed Pipe Insulation.
 - 6. ASTM C 553; Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
 - 7. ASTM C 612; Specification for Mineral Fiber Block and Board Thermal Insulation.
 - 8. ASTM C 1071; Specification for Thermal and Acoustical Insulation (Glass Fiber, Duct Lining Material).
 - 9. ASTM E 84; Test Method for Surface Burning Characteristics of Building Materials.
 - 10. ASTM E 96; Test Methods for Water Vapor Transmission of Materials.
 - 11. ASTM E 795; Practices for Mounting Test Specimens During Sound Absorption Tests.
 - 12. ASTM G 21; Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
- B. National Fire Protection Association (NFPA):
 - 1. NFPA 90A; Standard for the Installation of Air Conditioning and Ventilating Systems.
 - 2. NFPA 255; Standard Method of Test of Surface Burning Characteristics of Building Materials.

- C. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):
SMACNA Fibrous Glass Duct Construction Standards.
- D. Underwriters' Laboratories, Inc. (UL):
 - 1. UL 723; Test for Surface Burning Characteristics of Building Materials.

1.03 SUBMITTALS

- A. Product Data: As specified in Division 1; submittals required for the following items:
 - 1. Pipe Insulating Materials.
 - 2. Duct Insulating Materials.
 - 3. Equipment Insulating Materials.

1.04 DELIVERY, STORAGE AND HANDLING

- A. Deliver insulation products to the site in unbroken shipping cartons bearing a label. Show on the label the list of contents and the appropriate ASTM, NFPA and UL flame and smoke hazard ratings as specified herein.
- B. Deliver and store insulation products protected from the weather. Store insulation on the site elevated off wet and otherwise contaminating surfaces.

PART 2 PRODUCTS

2.01 PIPE INSULATING MATERIALS

- A. Materials Option: Two types of pipe insulation materials are specified herein at the Contractor's option for pipe insulating. However, mixing of insulation materials will not be permitted, but where specified otherwise herein or where directed otherwise by the COR.
- B. Rigid Insulation on Piping: Rigid one-piece glass fiber insulation with facing of white kraft bonded to metallic foil and reinforced with fiber glass yarn, hinged construction for use with sealing adhesive and manufactured to meet requirements of ASTM C 547.
 - 1. Basic Physical Properties:
 - a. Ensure products or their shipping cartons bear a label indicating compliance with the above standards.
 - b. Provide insulation manufacturer's companion joint making/sealing adhesive to make permanent insulation joints.

2.02 DUCT INSULATING MATERIALS

- A. Rigid Duct Insulation: (Exposed Mechanical Spaces) One-inch thickness, unless indicated otherwise on Drawings, glass fiber with factory applied foil-scrim-kraft facing reinforced with fiberglass yarn mesh, and manufactured to meet the requirements of ASTM C 612.
 - 1. Basic Physical Properties:
 - 2. Installation Materials:

B. Flexible Duct Wrap: (Concealed Spaces Above Ceilings) One and one-half inch thickness, unless indicated otherwise on Drawings, glass fiber blanket with reinforced foil and fiber glass scrim laminated to a UL rated kraft facing and manufactured to meet the requirements of ASTM C 553, Type I, Class B-3.

1. Basic Physical Properties:
2. Installation Materials:

PART 3 EXECUTION

3.01 INSPECTION

A. Carefully inspect installed work of other Trades in connection with insulating work and verify such work to be complete, including system or equipment testing, to such point where insulating work may begin.

3.02 PREPARATION

- A. Apply insulation on clean, dry surfaces only. Perform cleaning required for removal of construction debris, spills, etc.
- B. Personnel protective equipment may be necessary when working with insulation materials. Refer to the manufacturer's Material Safety Data Sheet (MSDS) for recommendations.

3.03 INSTALLATION

- A. Install insulation continuous through structure penetration of surfaces being insulated.
- B. Apply insulation on cold surfaces, where vapor barrier is integral with insulation in a continuous unbroken vapor seal. Adequately seal hanger, support, and anchor penetrations of insulation.
- C. Apply specified insulation adhesive, sealers and coatings at the manufacturer's recommended minimum coverage per gallon.
- D. Protect material from weather damage until weather protective jacket is applied.

3.04 PIPE INSULATING

- A. Apply insulation materials on piped services listed and in accordance with thickness listed in PART 2 or in the following paragraphs. Insulate fittings and valve bodies and in-line control devices, except gage and thermometer faces, setting or measuring scales integral with in-line devices and control handles.
- B. Flexible Insulation Installation: Install on piping according to manufacturer's instructions, using specified adhesive to seal both longitudinal and butt joints. Insulate in-line appurtenances to the same thickness as adjoining insulation.

1. Installed Thickness: Install FLEXIBLE piping insulation per the following schedule:

		inch(mm)
Domestic Cold Water	2 1/2" to 4 (65-100)	1 1/2(40)
Chilled Water (< 40(4.4))	Up to 1 (25)	1(25)
Chilled Water (< 40(4.4))	1 1/4" to 2 (32 – 50)	1 1/2(40)
Chilled Water (< 40(4.4))	2 1/2" to 6(65-150)	1 1/2(40)

2. Outdoor Installation: Weatherize insulation exposed to weather.

C. Rigid Insulation Installation: Install on piping according to manufacturer's instructions, using specified adhesive to seal both longitudinal jacket laps and butt strips. Insulate in-line appurtenances with a factory premolded one-piece insulated covers as previously specified. Secure fitting cover by stapling first followed by a tape sealing using tape as recommended by the fitting cover manufacturer.

- D. Installed Thickness: Install RIGID piping insulation per the following schedule:

		<u>inch(mm)</u>
Domestic Cold Water	2 1/2" to 4 (65-100)	1 1/2(40)
Domestic Hot Water (180(82.2))	Run-outs	1 (15)
Hot Water Heating	Run-outs	1(25)
Hot Water Heating	Up to 4 (100)	1 1/2(40)
Low Pressure Steam	Up to 1 (25)	1 1/2(40)
Low Pressure Steam	1 1/4" to 2 (32 – 50)	1 1/2(40)
Low Pressure Steam	2 1/2" to 4 (65-100)	2(50)
Condensate Return	Up to 1 (25)	1 1/2(40)
Condensate Return	1 1/4" to 2 (32 – 50)	1 1/2(40)
Condensate Return	2 1/2" to 4 (65-100)	2(50)
Chilled Water (< 40(4.4))	Up to 1 (25)	1(25)
Chilled Water (< 40(4.4))	1 1/4" to 2 (32 – 50)	1 1/2(40)
Chilled Water (< 40(4.4))	2 1/2" to 4 (65-100)	1 1/2(40)

1. Outdoor Installation: Weatherize insulation exposed to weather.

3.05 DUCT INSULATING

A. Rigid Duct Insulation Installation: Apply to exterior of formed sheet steel duct with vapor barrier facing out, using adhesive in 100 percent coverage so that insulation conforms to duct surfaces uniformly and firmly. Cut board square and even to assure snug joints.

1. Fasteners: In addition to adhesive, secure board insulation to bottom of ducts 18-inches or wider by means of welded pins and speed clips. Cut pins flush after speed clips have been installed.
2. Joint Seal: Use SMACNA registered joint tape to seal insulation joints and to make repairs in insulation vapor barrier jacket.
3. Wrap the following duct runs:

- B. Flexible Duct Wrap Installation: Apply to exterior of formed sheet steel duct with vapor barrier facing out and edges butted tightly. Fit duct wrap snugly around hangers and fittings with minimum compression of insulation at duct corners. Cut insulation slightly longer than the duct perimeter to insure full thickness at corners.
1. Adhesive Method: Apply approved adhesive in 100 percent coverage method to secure insulation on ducts. Tape seal joints with 3-inch (76.2mm) wide strips of joint closure tape.
 2. Fasteners: Contractor option to use weld-pin/speed-clip fasteners in lieu of adhesive method to secure duct wrap to ducts. Install fasteners with close enough spacing that insulation shows no evidence of sagging between fasteners. Tape and seal joints as specified above.
 3. Wrap the following duct runs:

- C. Minimum Duct insulation thickness per the following schedule:

<u>Duct Insulation</u>	<u>inches (mm)</u>
Cold Air Ducts	2.0 (50)
Relief Ducts	1.5 (40)
Warm Air Ducts	2.0 (50)

1. Maximum thickness for flexible elastomeric cellular insulation shall not exceed 1 inch(25) and maximum thickness for polyisocyanurate foam insulation shall not exceed 1.5 inch(40), to comply with ASTM E 84 flame spread/smoke developed ratings of 25/50.

- D. Rigid Insulation: Two-inch thickness, unless indicated otherwise on Drawings, expanded, closed cell, elastomeric structure or unicellular polyolifin foam insulation manufactured to meet requirements of ASTM C 534 in sheet and roll form.

1. Basic Physical Properties:
 - a. Density: 5 to 6 pounds per cubic foot.
 - b. Thermal Conductivity: not greater than 0.28 BTUH per sq. ft. per degree per inch at 75 degrees F. mean temperature when tested according to ASTM C 177.
 - c. Water Vapor Transmission: 0.1 perm-inch. or less when tested according to ASTM E 96.
 - d. Fire Rating: not exceeding 25 Flame Spread and 50 Smoke Developed when tested in accordance with ASTM E 84.
 - e. Temperature Limits: -40 degrees F. to 220 degrees F.
2. Provide insulation manufacturer's companion joint making/sealing adhesive to make permanent insulation joints.
3. Duct Accessories and Equipment: Insulate duct accessories and equipment, with the same sheet thickness as connecting ducts, unless noted otherwise on the Drawings.
4. Outdoor Installation: Provide manufacturer's recommended weather resistant protective coating or finish. Coating to be a water-based latex enamel or similar sealer.
5. Acceptable Manufacturers:

- a. Armstrong World Industries, Inc.; AP Armaflex
- b. Rubatex Corporation
- c. Or Equal.

END OF SECTION

SECTION 15140

DOMESTIC WATER PIPING

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: The work specified in this Section consists of constructing the piping systems including the basic control devices within the piping systems.
- B. Related Sections:
 - 1. Basic Mechanical Materials and Methods: Section 15050.
 - 2. Supports, Anchors and Seals: Section 15060.
 - 3. Mechanical Identification: Section 15075.

1.02 REFERENCES

- A. American National Standards Institute (ANSI):
 - 1. ANSI A13.1; Scheme for the Identification of Piping Systems.
 - 2. ANSI A21.4; Cement-Mortar Lining for Ductile-Iron and Gray-Iron Pipe and Fittings for Water.
 - 3. ANSI A21.10; Ductile-Iron and Gray-Iron Fittings, 3 through 48 in, for Water and Other Liquids.
 - 4. ANSI A21.15; Flanged Ductile-Iron and Gray-Iron Pipe with Threaded Flanges.
 - 5. ANSI A21.51; Ductile-Iron Pipe, Centrifugally Cast, in Metal Molds or Sand-Lined Molds for Water or Other Liquids.
 - 6. ANSI B16.18; Cast Copper Alloy Solder Joint Pressure Fittings.
 - 7. ANSI B16.22; Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
 - 8. ANSI B18.2.1; Square and Hex Bolts and Screws Inch Series Including Hex Cap Screws, and Lag Screws.
 - 9. ANSI B18.2.2; Square and Hex Nuts.
- B. American Society for Testing and Materials (ASTM):
 - 1. ASTM A 126; Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.
 - 2. ASTM A 278; Specification for Gray Iron Castings for Pressure-Containing Parts for Temperatures up to 650 Degrees F (345 Degrees C).
 - 3. ASTM A 307; Specification for Carbon Steel Externally Threaded Standard Fasteners.
 - 4. ASTM B 32; Specification for Solder Metal.
 - 5. ASTM B 42; Specification for Seamless Copper Pipe, Standard Sizes
 - 6. ASTM B 62; Specification for Composition Bronze or Ounce Metal Castings.
 - 7. ASTM B 88; Specification for Seamless Copper Water Tube.

8. ASTM B 584; Specification for Copper Alloy Sand Castings for General Applications.
- C. Manufacturer's Standardization Society (MSS) of the Valve and Fittings Industry, MSS-SP-70, MSS-SP-71 and MSS-SP-80.
- D. American Water Works
 1. AWWA C 500; Gate Valves for Water and Sewerage Sytems
 2. AWWA C 111; Rubber Gasket Joints for Ductile Iron Pressure Pipe.

1.03 SUBMITTALS

- A. Product Data: Submittals required for the following items:
 1. Valves (and Cocks).
 2. Pipe and Fittings.
 3. Meters and Gauges.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Valves, General Requirements: Provide valves of the same basic type, by the same product manufacturer, except where specifically specified otherwise. Each valve shall bear manufacturer's trademark, flow direction indication, and reference symbol indicating conditions for which it is guaranteed. Valves shall be suitable for 125 psi (856 kPa) and a minimum of 180 degrees F. (82 degrees C.) hot water. Valves shall have flanged end connections, except sizes smaller than 2 1/2" (62.6mm) may have threaded end connections for connections between bronze valves and copper tubing. Provide blue finish for cold water and red finish for hot water,
 1. Bronze Valves: Provide valves with pressure containing parts of materials of minimum physical properties in accordance with the specified Reference Standards.
 2. Gate and Globe Valves: Provide valves designed for repacking under pressure when fully opened, and equipped with packing suitable for the intended service. When the valve is fully opened, the back seal shall protect both packing and stem threads from the fluid.
- B. Pipe Line Support Materials: As specified in Section 15060.
- C. Pipe Identification and Valve Marking Materials: As specified in Section 15075.

2.02 DOMESTIC WATER PIPING, ABOVEGROUND INSIDE STRUCTURE

- A. Service Requirements:
 1. Cold Water Supply; maximum operating pressure of 100 psig (689.4kPa) and maximum operating temperature of 100 degrees F (38.1 degrees C.).

2. Hot Water Supply; maximum operating pressure of 100 psig (689.4kPa) and maximum operating temperature of 180 degrees F (82.8 degrees C.).
- B. Pipe: Type L Copper, Drawn ASTM B 88. Nominal Size 4 in.(100mm) and Smaller.
1. Joints: Soldered and Wiped.
 2. Nipples: ASTM B42, threaded end connection.
 3. Fittings: Wrought Copper or Bronze Solder-Joint Pressure ANSI B16.22.
 4. Unions: Cast Bronze ANSI B16.18 or Wrought Copper ANSI B16.22 Sweat Type.
 5. Solder: Lead Free Type ASTM B 32, 95-5 tin-antimony
 6. Flux: Chlorides of Zinc and Ammonium in Petroleum-Based Paste.
 7. Thread Lubricant: Graphite/Oil Compound or Polytetrafluoroethylene (PTFE) Tape. On Male Threads ONLY.
 8. Valves and Accessories: Gate valves or Ball valves may be used, but mixtures of valve types in a system not acceptable. Valve ends may be either threaded or solder, but mixtures of end types in a system not acceptable.
 - a. Ball Valves: Blowout Proof Stem, In-Line Disassembly Design, Bronze Body and Trim ASTM B 584, Full Port, TFE Seat. Two position lever handles.
 - b. Gate Valves: Class 125 Solid Bronze ASTM B 62, Rising Stem.
 - c. Check Valves: Class 125 Solid Bronze ASTM B 62, Horizontal Swing, Regrinding Type, Y-Pattern, Renewable Disc and Hinge Pin, Buna-N Seat Disc.
 - d. Strainers: Class 250 Bronze Body ASTM B 62, 316 S.S. 20 Mesh (.033 in. (0.84mm) Openings) Removable Screen, Threaded Cap with Blow-off and gate valve, Threaded Ends
- C. Testing: Hydrostatic at 50 percent over system operating pressure but not less than 100 psig (689.4kPa).
1. Locate test pressure source on upstream sides on lines containing check valves and set control valves in open position for test duration.
 2. Do not subject equipment, piping specialties or plumbing fixtures to test pressures.
 3. Isolate in-line items that may be damaged by test pressures.
 4. Maintain test pressure to within 3 psi (20.7kPa) of initial test pressure, without introduction of additional pressure, until an examination is made to determine each joint and connection leak free, but in no case less than four hours actual test time.
- D. Cleaning: After testing flush entire system, through each outlet, until free of sediment and other foreign matter.
- E. Disinfection: After system flushing perform system disinfection from valve at source of supply through each outlet and connected fixtures and equipment.
1. Fill system with disinfection solution of calcium hypochlorite or sodium hypochlorite at a concentration of 50 parts available chlorine per million parts of

- water. Proof test solution concentration at system outlets to ensure full system volume of treated water.
2. Retain solution in system for a minimum of 24 continuous hours, then drain and thoroughly flush system until potable water is test proven comparable to water quality from supply source.

PART 3 EXECUTION

3.01 PREPARATION

- A. Field Measurement: The Drawings are in general indicative of the Work, with symbols and notations for clarity. However, the Drawings are not an exact representation of all conditions involved, therefore, layout piping to suit actual field measurements.
 1. No extra compensation will be made for Work due to difference between indicated and actual dimensions.
 2. Submit to the COR for approval, details of proposed departures necessitated by field conditions or other causes.
- B. Interferences: Layout piping systems to compensate for structural interferences, to preserve headroom, and not to interfere with openings, passageways and equipment. Do not install piping with joints and fittings over motors, switchboards, panels, or similar electrical apparatus.

3.02 INSTALLATION

- A. General Requirements: The schematic drawings do not necessarily indicate every piping size or alignment. Provide the required pipe sizes, fittings, adapters, etc. as required to construct complete piping systems.
 1. Install piping concealed in those areas of the structures having hung ceilings and exposed in all other areas, except where indicated otherwise on the Drawings.
 2. Clean piping prior to installation and following installation to prepare for painting. Keep open ends of piping and pipe attachment openings on equipment capped or plugged until actual connections.
 3. Construct pipe runs from full lengths of pipe using short sections only for runs of less than full pipe length. Make changes in directions of pipe runs with fittings only.
 4. Cut pipes accurately to measurements established in the field and assemble in place without springing, forcing, excessive cutting or weakening of the structure.
 5. Install unions and flanges in accessible locations and whether indicated or not, install union adjacent to equipment and wherever removal of equipment for repair or replacement is required.
 6. Provide dielectric unions at points of connection of copper tubing and piping to ferrous metal piping or equipment.
 7. Provide reducing fittings where reduction in pipe sizes is necessary. Bushings will not be accepted.

8. Install ball or gate valves at inlets and outlets to each piece of equipment.
 9. Pipe Supports Installation: Place and support piping runs as specified in Section 15060.
- B. Exposed Piping: Install exposed piping parallel or perpendicular to the lines of the building structure and to compensate for structural interferences, to preserve headroom, and not to interfere with openings, passageways and equipment.
1. Install piping a sufficient distance from other work to permit clearance of not less than one inch between the piping or insulated piping and adjacent work.
 2. Install piping as close as possible to walls, overhead construction, columns, and similar to facilitate insulating work and removal of piping later.

3.03 PIPE JOINING

- A. General Requirements: Exercise care when making pipe joints and make joints in accordance with the pipe material manufacturer's recommendations and the following additional requirements.
1. In each instance of pipe joining, those portions of pipes involved must be absolutely clean just prior to assembly.
 2. If a joint is extremely difficult to assemble or is not completely sealed, disassemble the joint and correct the difficulty if possible. Remake the joint using new materials when necessary.
- B. Copper Tubing and Pipe Joints: Cut tubing and piping ends square, deburr and ream to size of original bore.
1. Solder: Prior to sweating, clean pipe ends and fitting surfaces involved in the joint, to bright metal without marring surfaces. Finished joints shall show no evidence of hard-temper due to over-heating, no evidence of improper solder draw, and excess solder must be removed.
 2. Flared: Cut tubing and piping ends square, deburr and ream to size of original bore. Finished joints shall show evenness of flaring and proper seating of joining parts.
 3. Brazing: Prior to brazing, clean the surfaces involved in the brazing to remove oxides and surface soil. Exercise care so as not to remove excess material to result in a loose fit of the joint. Perform brazing in accordance with recommendations of the Copper Development Association Inc. Copper, Brass, Bronze, Product Handbook.

3.04 FIELD QUALITY CONTROL

- A. General Requirements: Conduct tests specified under Piping System Specifications so that each piping system installed in the Project is tested to the COR's satisfaction.
1. Provide tools, materials (including clean water), apparatus and instruments necessary for piping system testing.
 2. Conduct tests of every kind in the presence of and to the satisfaction of the COR.
 3. Free piping systems of trapped air for tests involving water.

4. Perform tests involving water in the test only when there is no danger of water freezing during the test time period.
5. Repair and Retest: When a piping system fails to meet test requirements specified herein, conform to the following:
 - a. Determine source or sources of leakage.
 - b. Repair or replace defective material and if a result of improper workmanship, correct such.
 - c. Conduct additional tests to demonstrate that piping system meets specified test requirements.
 - d. Perform repair and retest work at no increase in Contract Price.
 - e. Accuracy Proof: Furnish acceptable proof to the COR that testing apparatus, pressure gauges, etc. have been recently checked and calibrated, as applicable, prior to use on this Project.
6. Notification: Give the COR a minimum of three days advance notice of the times when piping system acceptance testing will be conducted.

END OF SECTION

SECTION 15150

SANITARY WASTE AND VENT PIPING

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: The work specified in this Section consists of constructing the piping systems including the basic control devices within the piping systems.
- B. Related Sections:
 - 1. Trenching, Backfilling, and Compacting: Section 02221.
 - 2. Basic Mechanical Materials and Methods: Section 15050.
 - 3. Supports, Anchors, and Seals: Section 15060.

1.02 REFERENCES

- A. American National Standards Institute (ANSI):
 - 1. ANSI A13.1; Scheme for the Identification of Piping Systems.
 - 2. ANSI B16.22; Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
 - 3. ANSI B16.23; Cast Copper Alloy Solder Joint Drainage Fittings -- DWV.
 - 4. ANSI B16.29; Wrought Copper and Wrought Copper Alloy Solder-Joint Drainage Fittings -- DWV.
- B. American Society for Testing and Materials (ASTM):
 - 1. ASTM A 74; Specification for Cast Iron Soil Pipe and Fittings.
 - 2. ASTM B 32; Specification for Solder Metal.
 - 3. ASTM B 306; Specification for Copper Drainage Tube (DWV).
 - 4. ASTM C 564; Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
- C. Cast Iron Soil Pipe Institute, Cast Iron Soil Pipe and Fittings Handbook, CISPI Specifications HS-67 and 301.

1.03 SUBMITTALS

- A. Product Data: Submittals required for the following items:
 - 1. Pipe and Fittings.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Acceptable Manufacturers: In the following Piping System Specifications product manufacturers are specified for certain items. By naming such manufacturers no intent is implied to eliminate from consideration equivalent products made by other manufacturers.

2.02 SANITARY, WASTE AND VENT PIPING, ABOVEGROUND INSIDE STRUCTURE

- A. Service Requirements:
1. Sanitary and Soil Piping; Maximum operating temperature of 140 degrees F. (60.5 degrees C.)
 2. Sanitary Vent Piping; Maximum operating temperature of 140 degrees F. (60.5 degrees C.)
- B. Pipe: Type DWV Copper, Drawn ASTM B 306. Nominal Size 1-1/2" in. (40mm) and Smaller.
1. Fittings: Wrought Copper ANSI B16.29, Cast Bronze ANSI B16.23 or ANSI/ASTM B 16.32 Solder Joint.
 2. Solder: 95/5 Tin-Antimony ASTM B 32.
 3. Flux: Chlorides of Zinc and Ammonium in Petroleum-Based Paste.
- C. Pipe: Service Weight Hubless Design (No-Hub) Cast Iron CISPI 301 with 310 Couplings.
1. Fittings Service Weight Hubless Design (No-Hub) Cast Iron CISPI 301.
 2. Joints: Neoprene Sleeve/300 Series Stainless Clamp and Shield Assembly CISPI 301.
- D. Pipe: Service Weight Hub and Spigot Design Cast Iron, ASTM A74
1. Fittings: Service Weight Hub and Spigot Design Cast Iron, ASTM A74.
 2. Joints: ASTM C564 Rubber Compression Gasket Joints.
- E. Testing: Ten foot head hydrostatic; 15-minutes test duration time, and until an examination is made to determine each joint and connection leak free.
1. Plug all system openings except highest opening, and fill system with water to point of overflow.
 2. When testing by sections plug all openings except highest opening in section under test and fill section with water; no section tested with less than 10 foot head (30.3 kPa) of water. In testing successive sections, include the upper 10 feet (3.05 m) of next preceding section in the test so no joints are tested at less than 10 foot head (30.3 kPa) of water.
- F. Cleaning: Flush out system using test water with sediment collection at lowest point in system.

2.03 LABORATORY WASTE AND VENT PIPING, ABOVEGROUND INSIDE STRUCTURE

- A. Pipe: Polypropylene plastic, conforming to ASTM F1412 and ASTM D4101, flame-retardant.
 - 1. Fittings. Schedule 40, Polypropylene plastic, conforming to ASTM F1412 and ASTM D4101, flame-retardant, long radius.
 - 2. Joints: Mechanical joint type coupling. 300 series stainless steel outer band, hardware meeting ASTM B117
- B. Testing: Ten foot head hydrostatic; 15-minutes test duration time, and until an examination is made to determine each joint and connection leak free.
 - 1. Plug all system openings except highest opening, and fill system with water to point of overflow.
 - 2. When testing by sections plug all openings except highest opening in section under test and fill section with water; no section tested with less than 10 foot head (30.3 kPa) of water. In testing successive sections, include the upper ten feet of next preceding section in the test so no joints are tested at less than 10 foot head (30.3 kPa) of water.
- C. Cleaning: Flush out system using test water with sediment collection at lowest end of system.

PART 3 EXECUTION

3.01 PREPARATION

- A. Field Measurement: The Drawings are in general indicative of the Work, with symbols and notations for clarity. However, the Drawings are not an exact representation of all conditions involved, therefore, layout piping to suit actual field measurements.
 - 1. No extra compensation will be made for Work due to difference between indicated and actual dimensions.
 - 2. Submit to the COR for approval, details of proposed departures necessitated by field conditions or other causes.
- B. Interferences: Layout piping systems to compensate for structural interferences, to preserve headroom, and not to interfere with openings, passageways and equipment. Do not install piping with joints and fittings over motors, switchboards, panels, or similar electrical apparatus.

3.02 INSTALLATION

- A. General Requirements: The schematic drawings do not necessarily indicate every piping size or alignment. Provide the required pipe sizes, fittings, adapters, etc. as required to construct complete piping systems.

1. Install piping concealed in those areas of the structures having hung ceilings and exposed in all other areas, except where indicated otherwise on the Drawings.
2. Clean piping prior to installation and following installation to prepare for painting. Keep open ends of piping and pipe attachment openings on equipment capped or plugged until actual connections.
3. Construct pipe runs from full lengths of pipe using short sections only for runs of less than full pipe length. Make changes in directions of pipe runs with fittings only.
4. Cut pipes accurately to measurements established in the field and assemble in place without springing, forcing, excessive cutting or weakening of the structure.
5. Provide increasing fittings where increases in pipe sizes is necessary.
6. Pipe Supports Installation: Place and support piping runs as specified in Section 15060.

B. Soil or Waste and Vent Piping Installation Requirements:

1. Changes in Direction: Make changes in direction in soil or waste piping using the appropriate sanitary fittings according to the BOCA Basic Plumbing Code; except that sanitary tees may be used on vertical stacks, and short quarter bends or elbows may be used where the change in direction of flow is from horizontal to vertical.
2. Where it becomes necessary to use short radius fittings because of space limitations, do so only with prior approval of the COR.
3. Slip Joints: Slip joints permitted only in factory fabricated chrome plated trap seals for fixtures. Use drainage fitting unions for making union connections wherever practicable. The use of continuous thread bushings is prohibited.
4. Traps: Provide a trap at the connection of each plumbing fixture, drain (except roof and outside drains) and piece of equipment requiring connection to soil or waste piping except where noted on the Drawings. Install traps as close as possible to the fixture, drain or piece of equipment; double trapping not permitted.
5. Test Tees: Install test tees at the base of vertical soil or waste piping runs and at the base of vertical rainwater conductor runs. Install threaded brass or bronze plug to close test opening. Test Tees may be omitted where cleanouts are required at test tee locations.
6. Vents: Extend vent pipes to not less than 10 inches (250mm) nor more than 18 inches (450mm) above the roof line. Additional installation requirements as follows:
 - a. Where vents extend to the roof line in less than three-inch pipe size, increase such to three-inches at least one foot below the roof and extend through the roof (to prevent frost closure).
 - b. Vents on grade, or in a high foot traffic area on the roof, shall terminate in a 180 degree bend with bird screen cap on the end; or extend such vents straight and install a Hooded Vent Cap on the end.
 - c. Where vents are taken on horizontal runs of soil or waste piping make such connections above the center-line of the piping, either on the top or at 45 degree angle. Additionally, make such vent connections at least 6-inches (150mm) above the flood-level rim at the highest fixture served by the same piping run.

- d. Locate sanitary vents through roof at a minimum distance of 25 feet (7.62m) from outside air intakes.
- C. Exposed Piping: Install exposed piping parallel or perpendicular to the lines of the building structure and to compensate for structural interferences, to preserve headroom, and not to interfere with openings, passageways and equipment.
- 1. Install piping a sufficient distance from other work to permit clearance of not less than one inch between the piping or insulated piping and adjacent work.
 - 2. Install piping as close as possible to walls, overhead construction, columns, and similar to facilitate insulating work and removal of piping later.

3.03 PIPE JOINING

- A. General Requirements: Exercise care when making pipe joints and make joints in accordance with the pipe material manufacturer's recommendations and the following additional requirements.
- 1. In each instance of pipe joining, those portions of pipes involved must be absolutely clean just prior to assembly.
 - 2. If a joint is extremely difficult to assemble or is not completely sealed, disassemble the joint and correct the difficulty if possible. Remake the joint using new materials when necessary.
- B. Copper Tubing and Pipe Joints: Cut tubing and piping ends square, deburr and ream to size of original bore.
- 1. Solder: Prior to sweating, clean pipe ends and fitting surfaces involved in the joint, to bright metal without marring surfaces. Finished joints shall show no evidence of hard-temper due to over-heating, no evidence of improper solder draw, and excess solder must be removed.
 - 2. Flared: Cut tubing and piping ends square, deburr and ream to size of original bore. Finished joints shall show evenness of flaring and proper seating of joining parts.
 - 3. Brazing: Prior to brazing, clean the surfaces involved in the brazing to remove oxides and surface soil. Exercise care so as not to remove excess material to result in a loose fit of the joint. Perform brazing in accordance with recommendations of the Copper Development Association Inc. Copper, Brass, Bronze, Product Handbook.

3.04 FIELD QUALITY CONTROL

- A. General Requirements: Conduct tests specified under Piping System Specifications so that each piping system installed in the Project is tested to the COR's satisfaction.
- 1. Provide tools, materials (including clean water), apparatus and instruments necessary for piping system testing.
 - 2. Conduct tests of every kind in the presence of and to the satisfaction of the COR.
 - 3. Free piping systems of trapped air for tests involving water.

4. Perform tests involving water in the test only when there is no danger of water freezing during the test time period.
 5. Repair and Retest: When a piping system fails to meet test requirements specified herein, conform to the following:
 - a. Determine source or sources of leakage.
 - b. Repair or replace defective material and if a result of improper workmanship, correct such.
 - c. Conduct additional tests to demonstrate that piping system meets specified test requirements.
 - d. Perform repair and retest work at no increase in Contract Price.
 6. Accuracy Proof: Furnish acceptable proof to the COR that testing apparatus, pressure gauges, etc. have been recently checked and calibrated, as applicable, prior to use on this Project.
 7. Notification: Give the COR a minimum of three days advance notice of the times when piping system acceptance testing will be conducted.
- B. Drainage and Vent Systems Test Option: Hydrostatic tests are specified; however, when there is danger of water freezing during the test time period conduct such tests using air pressure.
1. Air Test: Introduce compressed air in any suitable opening, after closing all other inlets and outlets, until there is a uniform gauge pressure of 5 psi (35mm) or sufficient to balance a column of mercury 10 inches (250mm) in height. Maintain pressure without introduction of additional air for a period of at least 15 minutes and until a soap suds solution test/examination is made to determine such joint and connection leak free.

END OF SECTION

SECTION 15180

HYDRONIC HEATING AND COOLING PIPING

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: The work specified in this Section consists of constructing the piping systems including the basic control devices within the piping systems.
- B. Related Sections:
 - 1. Basic Mechanical Materials and Methods: Section 15050.
 - 2. Supports, Anchors, and Seals: Section 15060.
 - 3. Mechanical Identification: Section 15075.

1.02 REFERENCES

- A. American National Standards Institute (ANSI):
 - 1. ANSI B16.10; Face-to-Face and End-to-End Dimensions of Ferrous Valves.
 - 2. ANSI B16.18; Cast Copper Alloy Solder Joint Pressure Fittings.
 - 3. ANSI B16.22; Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
- B. American Society for Testing and Materials (ASTM):
 - 1. ASTM B 32; Specification for Solder Metal.
 - 2. ASTM B 88; Specification for Seamless Copper Water Tube.
 - 3. ASTM B 584; Specification for Copper Alloy Sand Castings for General
- C. Manufacturer's Standardization Society (MSS) of the Valve and Fittings Industry, MSS-SP-70 and MSS-SP-71.

1.03 SUBMITTALS

- A. Product Data: Submittals required for the following items:
 - 1. Valves (and Cocks).
 - 2. Mechanical Pipe Couplings.
 - 3. Pipe and Fittings.
 - 4. Meters and Gages.
 - 5. Specialties.
 - 6. Prefabricated/Preinsulated Pipe and Fittings
- B. Shop Drawings: Submittals required for the following items:
 - 1. Prefabricated/Preinsulated Piping System dimensioned layout drawings and installation details

PART 2 PRODUCTS

2.01 MATERIALS

- A. Acceptable Manufacturers: In the following Piping System Specifications product manufacturers are specified for certain items. By naming such manufacturers no intent is implied to eliminate from consideration equivalent products made by other manufacturers.
- B. Valves, General Requirements: Provide valves of the same basic type, by the same product manufacturer, except where specifically specified otherwise. Each valve shall bear manufacturer's trademark, flow direction indication, and reference symbol-indicating conditions for which it is guaranteed. Provide valves of pressure and temperature ratings of not less than the design criteria as applicable to the pipe system components.
 - 1. Bronze Valves: Provide valves with pressure containing parts of materials of minimum physical properties in accordance with the specified Reference Standards.
 - 2. Iron and/or Steel Body Valves: Provide valves conforming to ANSI B16.10 for face-to-face and end-to-end dimensions. Valve design, quality, materials and testing shall conform to MSS-SP-70 and MSS-SP-71; with pressure containing parts also of materials of minimum physical properties in accordance with the specified Reference Standards.
- C. Pipe Identification and Valve Marking Materials: As specified in Section 15075.
- D. Pipe Line Support Materials: As specified in Section 15060.

2.02 METERS AND GAUGES

- A. Thermometers: Straight form, front red appearing mercury tube type in 6-1/2 inch (165.1 mm) cast aluminum case and one piece clear combination frame/ unbreakable front window and separable socket.
 - 1. Scale in black figures on white background. Scale graduated so as to show system design point temperature at midpoint of scale.
 - 2. Acceptable Manufacturers:
 - a. H. O. Trerice
 - b. Marsh Instrument.
 - c. Taylor Instrument.
 - d. Weksler Instruments Corporation.
 - e. Or Approved Equal.
- B. Pressure Gauges: 3-1/2-inch (88.9 mm) diameter cast aluminum case with a clear glass window and a 1/4-inch (6mm) outlet socket connected into a needle valve. Movement via brass milled teeth activated by a tube of phosphor bronze.

1. Scale in black figures on white background. Scale shall indicate zero to 1-1/2 times the working pressure in the system in which gauge is installed.
2. Acceptable Manufacturers:
 - a. H. O. Trerice
 - b. Marsh Instrument.
 - c. Taylor Instrument.
 - d. Weksler Instruments Corporation.
 - e. Or Approved Equal.

2.03 SPECIALTY VALVES

- A. Butterfly Valves (larger than 2-inch (50 mm).): Provide corrosion resistant construction valves for installation between ANSI 125 lb. or 150 lb. Flanges. Provide valves suitable for working pressures of 150 psi (1034 kPa), temperature range of plus 10 to plus 180 degrees F (-12.2 to plus 82.2 degrees C.) and with drip tight shutoff.
 1. Body: Cast iron ASTM A126 Grade B with reinforced resilient seats of BUNA-N elastomer, rated to plus 180 degrees F. (82.2 degrees C.)
 2. Disc: Aluminum-Bronze Disc
 3. Bearings: Nylon.
 4. Acceptable Manufacturers:
 - a. Crane Co.
 - b. Clow Corp.
 - c. Victaulic
 - d. Or Approved Equal.
- B. Ball Valves: (2-inch (50mm) and less) Provide corrosion resistant construction valves for installation between ANSI 125 lb (861.8 kPa) Flanges. Provide valves suitable for working pressures of 150 psi (1034.2 kPa) , temperature range of plus 10 degrees F to plus 180 F (-12.2 degrees C to 82.2 degrees C) and with drip tight shutoff.
 1. Body: two –piece body, bronze body and trim ASTM B 584 400 PSI WOG/125 PSI S-steam.
 2. Seat: TFE Seat with Blowout Proof Stem
 3. Acceptable Manufacturers:
 - a. NIBCO
 - b. Victaulic
 - c. Or Approved Equal

2.04 HEATING WATER PIPING, ABOVEGROUND INSIDE STRUCTURE

- A. Service Requirements:
 1. Heating Hot Water Supply; maximum operating pressure of 100 psig (689.5 kPa) and maximum operating temperature of 200 degrees F (93.3 degrees C).
 2. Heating Hot Water Return; maximum operating pressure of 100 psig (689.5 kPa) and maximum operating temperature of 200 degrees F (93.3 degrees C).
 3. Chemical Treatment; maximum operating pressure of 100 psig (689.5 kPa) and maximum operating temperature of 85 degrees F (29.4 degrees C).

4. Condensate Drain; maximum operating temperature of 100 degrees F (37.7 degrees C).
- B. Pipe: Type L Copper, Drawn ASTM B 88. Nominal Size 4-inch. (100 mm) and Smaller.
1. Joints: Soldered and wiped.
 2. Nipples: Same as Pipe.
 3. Fittings: Wrought Copper or Bronze Solder-Joint Pressure ANSI B16.22.
 4. Unions: Cast Bronze ANSI B16.18 or Wrought Copper ANSI B16.22 Sweat Type.
 5. Solder: 95/5 Tin-Antimony ASTM B 32.
 6. Flux: Chlorides of Zinc and Ammonium in Petroleum-Based Paste.
 7. Thread Lubricant: Graphite/Oil Compound or Polytetrafluoroethylene (PTFE) Tape. On Male Threads ONLY.
 8. Strainers: Class 250 Bronze Body ASTM B 62, 316 S.S. 20 Mesh (.033 in. (.84 mm) Openings) Removable Screen, Threaded Cap with Blow-off, Threaded Ends; Sarco Type BT.
- C. Valves:
1. Valve Ends Option: Valve ends may be either threaded or solder. Mixtures of end types in a system not acceptable.
 2. Ball Valves: Blowout Proof Stem 400 PSI WOG/125 PSI S-steam, Two-Piece Body; Bronze Body and Trim ASTM B 584, TFE Seat, Soldered Ends; NIBCO Fig. S-580-BR-Y.
 3. Check Valves: Class 125 Solid Bronze ASTM B 62, Horizontal Swing, Regrinding Type, Y-Pattern, Renewable Disc and Hinge Pin, TFE Seat Disc; NIBCO Fig. T-413-Y Threaded and Fig. S-413-Y Solder.
- D. Pipe: Black Steel Schedule 40 ASTM A 53. Nominal Size 2-inch (50 mm) and Smaller.
1. Joints: Threaded.
 2. Nipples: Same as Pipe except Schedule 80.
 3. Fittings: Malleable Iron 150 lb. (1034.2 kPa) Threaded ASTM A 47 and ANSI B16.3.
 4. Unions: Malleable Iron 150 lb. (1034.2 kPa) Threaded, Ground Joint Bronze to Iron ASTM A 197 and ANSI B2.1.
 5. Thread Lubricant: Graphite/Oil Compound or Polytetrafluoroethylene (PTFE) Tape. On Male Threads ONLY.
 6. Strainers: Class 250 Bronze Body ASTM B 62, 316 S.S. 20 Mesh (.033 in. Openings) Removable Screen, Threaded Cap with Blow-off, Threaded Ends; Sarco Type BT.
- E. Valves:
1. Ball Valves: Blowout Proof Stem 400 PSI WOG/125 PSI S-steam, Two-Piece Body; Bronze Body and Trim ASTM B 584, TFE Seat, Threaded Ends; NIBCO Fig. T-580-BR-Y.

2. Check Valves: Class 125 Solid Bronze ASTM B 62, Horizontal Swing, Re grinding Type, Y-Pattern, Renewable Disc and Hinge Pin, TFE Seat Disc; NIBCO Fig. T-413-Y Threaded Ends.
- F. Pipe: Black Steel Schedule 40 ASTM A 53. Nominal Size 2-1/2-inch (60 mm) and Larger.
1. Joints: Grooved joints
 2. Fittings: Wrought Carbon Steel Standard Weight Welding ASTM A 234 Grade WPB or WPC and ANSI B16.9.
 3. Unions: Forged Carbon Steel Welding-Neck 150 lb. Raised-Face (Except Flat-Face Against Valves) Flanges ASTM A 181 and ANSI B16.1.
 4. Gaskets: 1/16 in. (1.6 mm) Thick Mineral Fiber Composition (Non-Metallic) ANSI B16.21.
 5. Bolts: Carbon Steel Hex Bolts and Nuts ASTM A 307 Grade B.
 6. Strainers: Class 125 Semi-Steel Body ASTM A 278 Class 30, 316 S.S. 20 Mesh (.033 in. (.84 mm) Openings) Removable Screen, Bolted Cap with Blow-off, Flanged Ends; Sarco Type AF-125.
- G. Valves:
1. Butterfly Valves: 200 psi (1378.9 kPa) Ductile Iron Lug Style Body, ASTM A 536, Extended Neck, Geometric Drive, Fully-Supported EPDM Rubber Liner, Aluminum-Bronze Disc, O-Ring EPDM Body and Stem Seals, Lever-Lock Operator; NIBCO Fig. LD-2000.
 2. Check Valves: Class 125 Iron Body Bronze Mounted ASTM A 126 and B 62, Swing Valves: Check, Bolted Cap, Renewable Parts (Seat, Disc, Hinge Pin), Flanged Ends; NIBCO Fig. F-918-B.
 3. The use of Victaulic valves and fittings is acceptable.
- H. Testing: Hydrostatic at 50 percent over system operating pressure but not less than 100 psig (689.5 kPa).
1. Locate test pressure source on upstream sides on lines containing check valves and set control valves in open position for test duration.
 2. Isolate in-line items that may be damaged by test pressures.
 3. Maintain test pressure to within 3 psi (20.7 kPa) of initial test pressure, without introduction of additional pressure, until an examination is made to determine each joint and connection leak free, but in no case less than four hours actual test time.
- I. Cleaning: After testing perform system boil-out using solution of soda ash at the rate of one pound per twenty gallons of clean water to remove sediment (thread lubricant, oil, loose mill scale and other extraneous deposits caused by assembly methods).
1. System piping and heat generating equipment boil-out may be performed as one operation.
 2. Following system boil-out flush out entire system with clean hot water rinse until system is free of sediment and boil-out solution residue.

2.05 CHILLED WATER PIPING, ABOVEGROUND INSIDE STRUCTURE

A. Service Requirements:

1. Chilled Water Supply; maximum operating pressure of 100 psig (689.5 kPa) and maximum operating temperature of 50 degrees F (10 degrees C).
2. Chilled Water Return; maximum operating pressure of 100 psig (689.5 kPa) and maximum operating temperature of 60 degrees F (15.6 degrees C).
3. Glycol Cooling Water Supply; maximum operating pressure of 100 psig (689.5 kPa) and maximum operating temperature of 85 degrees F (29.4 degrees C).
4. Glycol Cooling Water Return; maximum operating pressure of 100 psig (689.5 kPa) and maximum operating temperature of 95 degrees F (35 degrees C).
5. Condensate Drain; maximum operating temperature of 100 degrees F (37.8 degrees C).
6. Chemical Treatment; maximum operating pressure of 100 psig (689.5 Kpa) and maximum operating temperature of 85 degrees (29.4 degrees C).

B. Pipe: Type L Copper, Drawn ASTM B 88. Nominal Size 4-in. (100 mm) and Smaller.

1. Joints: Soldered and wiped.
2. Nipples: Same as Pipe.
3. Fittings: Wrought Copper or Bronze Solder-Joint Pressure ANSI B16.22.
4. Unions: Cast Bronze ANSI B16.18 or Wrought Copper ANSI B16.22 Sweat Type.
5. Solder: 95/5 Tin-Antimony ASTM B 32.
6. Flux: Chlorides of Zinc and Ammonium in Petroleum-Based Paste.
7. Thread Lubricant: Graphite/Oil Compound or Polytetrafluoroethylene (PTFE) Tape. On Male Threads ONLY.
8. Strainers: Class 250 Bronze Body ASTM B 62, 316 S.S. 20 Mesh (.033 in. (.84 mm) Openings) Removable Screen, Threaded Cap with Blow-off, Threaded Ends; Sarco Type BT.

C. Valves:

1. Valve Ends Option: Valve ends may be either threaded or solder. Mixtures of end types in a system not acceptable.
2. Ball Valves: Blowout Proof Stem 400 PSI WOG/125 PSI S-steam, Two-Piece Body; Bronze Body and Trim ASTM B 584, TFE Seat, Soldered Ends; NIBCO Fig. S-580-BR-Y.
3. Check Valves: Class 125 Solid Bronze ASTM B 62, Horizontal Swing, Regrinding Type, Y-Pattern, Renewable Disc and Hinge Pin, TFE Seat Disc; NIBCO Fig. T-413-Y Threaded and Fig. S-413-Y Solder.

D. Pipe: Black Steel Schedule 40 ASTM A 53. Nominal Size 2-inch. (50 mm) and Smaller.

1. Joints: Threaded.
2. Nipples: Same as Pipe except Schedule 80.
3. Fittings: Malleable Iron 150 lb. (1034.2 kPa) Threaded ASTM A 47 and ANSI B16.3.

4. Unions: Malleable Iron 150 lb. (1034.2 kPa) Threaded, Ground Joint Bronze to Iron ASTM A 197 and ANSI B2.1.
5. Thread Lubricant: Graphite/Oil Compound or Polytetrafluoroethylene (PTFE) Tape. On Male Threads ONLY.
6. Strainers: Class 250 Bronze Body ASTM B 62, 316 S.S. 20 Mesh (.033 in. (.84 mm) Openings) Removable Screen, Threaded Cap with Blow-off, Threaded Ends; Sarco Type BT.

E. Valves:

1. Ball Valves: Blowout Proof Stem 400 PSI WOG/125 PSI S-steam, Two-Piece Body; Bronze Body and Trim ASTM B 584, TFE Seat, Threaded Ends; NIBCO Fig. T-580-BR-Y.
2. Check Valves: Class 125 Solid Bronze ASTM B 62, Horizontal Swing, Re grinding Type, Y-Pattern, Renewable Disc and Hinge Pin, TFE Seat Disc; NIBCO Fig. T-413-Y Threaded Ends.

F. Pipe: Black Steel Schedule 40 ASTM A 53. Nominal Size 2-1/2 inch (65 mm) and Larger.

1. Joints: Grooved ends
2. Fittings: Wrought Carbon Steel Standard Weight Welding ASTM A 234 Grade WPB or WPC and ANSI B16.9.
3. Unions: Forged Carbon Steel Welding-Neck 150 lb. Raised-Face (Except Flat-Face Against Valves) Flanges ASTM A 181 and ANSI B16.1..
4. Gaskets: 1/16 in. (1.6 mm) Thick Mineral Fiber Composition (Non-Metallic) ANSI B16.21.
5. Bolts: Carbon Steel Hex Bolts and Nuts ASTM A 307 Grade B.
6. Strainers: Class 125 Semi-Steel Body ASTM A 278 Class 30, 316 S.S. 20 Mesh (.033 in. (.84 mm) Openings) Removable Screen, Bolted Cap with Blow-off, Flanged Ends; Sarco Type AF-125.

G. Valves:

1. Butterfly Valves: 200 psi (1379 Kpa) Ductile Iron Lug Style Body, ASTM A 536, Extended Neck, Geometric Drive, Fully-Supported EPDM Rubber Liner, Aluminum-Bronze Disc, O-Ring EPDM Body and Stem Seals, Lever-Lock Operator; NIBCO Fig. LD-2000.
2. Check Valves: Class 125 Iron Body Bronze Mounted ASTM A 126 and B 62, Swing Valves: Check, Bolted Cap, Renewable Parts (Seat, Disc, Hinge Pin), Flanged Ends; NIBCO Fig. F-918-B.
3. The use of Victaulic valves and fittings is acceptable.

H. Testing: Hydrostatic at 50 percent over system operating pressure but not less than 125 psig (861.8 kPa).

1. Locate test pressure source on upstream sides on lines containing check valves and set control valves in open position for test duration.
2. Isolate in-line items that may be damaged by test pressures.

3. Maintain test pressure to within 3 psi (20.7 kPa) of initial test pressure, without introduction of additional pressure, until an examination is made to determine each joint and connection leak free, but in no case less than four hours actual test time.
- I. Cleaning: After testing perform system boil-out using solution of soda ash at the rate of one pound (.45 Kg) per twenty gallons (75.7 L) of clean water to remove sediment (thread lubricant, oil, loose mill scale and other extraneous deposits caused by assembly methods).
1. System piping and heat generating equipment boil-out may be performed as one operation.
 2. Following system boil-out flush out entire system with clean hot water rinse until system is free of sediment and boil-out solution residue.

PART 3 EXECUTION

3.01 PREPARATION

- A. Field Measurement: The Drawings are in general indicative of the Work, with symbols and notations for clarity. However, the Drawings are not an exact representation of all conditions involved, therefore, layout piping to suit actual field measurements.
1. No extra compensation will be made for Work due to difference between indicated and actual dimensions.
 2. Submit to the COR for approval, details of proposed departures necessitated by field conditions or other causes.
- B. Interferences: Layout piping systems to compensate for structural interferences, to preserve headroom, and not to interfere with openings, passageways and equipment. Do not install piping with joints and fittings over motors, switchboards, panels, or similar electrical apparatus.

3.02 INSTALLATION

- A. General Requirements: The schematic drawings do not necessarily indicate every piping size or alignment. Provide the required pipe sizes, fittings, adapters, etc. as required to construct complete piping systems.
1. Install piping concealed in those areas of the structures having hung ceilings and exposed in all other areas, except where indicated otherwise on the Drawings.
 2. Clean piping prior to installation and following installation to prepare for painting. Keep open ends of piping and pipe attachment openings on equipment capped or plugged until actual connections.
 3. Construct pipe runs from full lengths of pipe using short sections only for runs of less than full pipe length. Make changes in directions of pipe runs with fittings only.

4. Cut pipes accurately to measurements established in the field and assemble in place without springing, forcing, excessive cutting or weakening of the structure.
 5. Install unions and flanges in accessible locations and whether indicated or not, install union adjacent to equipment and wherever removal of equipment for repair or replacement is required.
 6. Provide dielectric unions at points of connection of copper tubing and piping to ferrous metal piping or equipment.
 7. Provide reducing fittings where reduction in pipe sizes is necessary. Bushings will not be accepted.
 8. Install gate valves at inlets and outlets to each piece of equipment.
 9. Pipe Supports Installation: Place and support piping runs as specified in Section 15060.
- B. Exposed Piping: Install exposed piping parallel or perpendicular to the lines of the building structure and to compensate for structural interferences, to preserve headroom, and not to interfere with openings, passageways and equipment.
1. Install piping a sufficient distance from other work to permit clearance of not less than one inch between the piping or insulated piping and adjacent work.
 2. Install piping as close as possible to walls, overhead construction, columns, and similar to facilitate insulating work and removal of piping later.
- C. Thermometer and Gauge Installations:
1. Thermometer in Piping: Provide thermometer with 3/4-inch (20 mm) NPT separable socket of noncorrosive material and with 2 3/4-inch (69.8 mm) extension neck and stem of a length to reach the center line of the pipe.
 2. Pressure Gauges in Piping: Provide pressure gauge with 1/4-inch (6 mm) NPT separable socket of noncorrosive material and with 1/4-inch (6 mm) brass nipple for installation of gauge cock.

3.03 PIPE JOINING

- A. General Requirements: Exercise care when making pipe joints and make joints in accordance with the pipe material manufacturer's recommendations and the following additional requirements.
1. In each instance of pipe joining, those portions of pipes involved must be absolutely clean just prior to assembly.
 2. If a joint is extremely difficult to assemble or is not completely sealed, disassemble the joint and correct the difficulty if possible. Remake the joint using new materials when necessary.
- B. Copper Tubing and Pipe Joints: Cut tubing and piping ends square, deburr and ream to size of original bore.
1. Solder: Prior to sweating, clean pipe ends and fitting surfaces involved in the joint, to bright metal without marring surfaces. Finished joints shall show no evidence of hard-temper due to over-heating, no evidence of improper solder draw, and excess solder must be removed.

2. Flared: Cut tubing and piping ends square, deburr and ream to size of original bore. Finished joints shall show evenness of flaring and proper seating of joining parts.
 3. Brazing: Prior to brazing, clean the surfaces involved in the brazing to remove oxides and surface soil. Exercise care so as not to remove excess material to result in a loose fit of the joint. Perform brazing in accordance with recommendations of the Copper Development Association Inc. Copper, Brass, Bronze, Product Handbook.
- C. Ferrous Metal Piping Joints: Cut pipe ends square, deburr and ream to size of original bore.
1. Threaded: Cut threads to standard gauge depth and length and clean threads free of oil and cuttings. Provide thread lubricant as specified to aid in joint lubrication and sealing in joining operation.
 2. Welded: Responsibility for quality of welding, competency of welding operators and their ability to make sound welds rests with the Contractor. Technique of welding employed, appearance and quality of welds made and methods used in correcting defective work shall conform to requirements of ANSI B31.1 and its Supplements.
 3. Flanged: Face accurately, install gaskets and draw up square and tight to ensure full gasket flow and seal.
 4. O-ring Push Joints in accordance with manufacturers recommended installation practices.

3.04 FIELD QUALITY CONTROL

- A. General Requirements: Conduct tests specified under Piping System Specifications so that each piping system installed in the Project is tested to the COR's satisfaction.
1. Provide tools, materials (including clean water), apparatus and instruments necessary for piping system testing.
 2. Conduct tests of every kind in the presence of and to the satisfaction of the COR.
 3. Free piping systems of trapped air for tests involving water.
 4. Perform tests involving water in the test only when there is no danger of water freezing during the test time period.
 5. Repair and Retest: When a piping system fails to meet test requirements specified herein, conform to the following:
 - a. Determine source or sources of leakage.
 - b. Repair or replace defective material and if a result of improper workmanship, correct such.
 - c. Conduct additional tests to demonstrate that piping system meets specified test requirements.
 - d. Perform repair and retest work at no increase in Contract Price.
 6. Accuracy Proof: Furnish acceptable proof to the COR that testing apparatus, pressure gauges, etc. have been recently checked and calibrated, as applicable, prior to use on this Project.

7. Notification: Give the COR a minimum of three days advance notice of the times when piping system acceptance testing will be conducted.

END OF SECTION

SECTION 15185

STEAM AND STEAM CONDENSATE PIPING

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: The work specified in this Section consists of constructing the steam and steam condensate piping systems including the basic control devices within the piping systems.
- B. Related Sections:
 - 1. Basic Mechanical Materials and Methods: Section 15050.
 - 2. Supports, Anchors, and Seals: Section 15060
 - 3. Mechanical Identification: Section 15075
 - 4. Mechanical Insulation: Section 15080.

1.02 REFERENCES

- A. American National Standards Institute (ANSI):
 - 1. ANSI A13.1; Scheme for the Identification of Piping Systems.
 - 2. ANSI A21.4; Cement-Mortar Lining for Ductile-Iron and Gray-Iron Pipe and Fittings for Water.
 - 3. ANSI A21.10; Ductile-Iron and Gray-Iron Fittings, 3 through 48-inch (80 through 1200 mm), for Water and Other Liquids.
 - 4. ANSI A21.11; Rubber Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings.
 - 5. ANSI A21.15; Flanged Ductile-Iron and Gray-Iron Pipe with Threaded Flanges.
 - 6. ANSI A21.50; Thickness Design of Ductile-Iron Pipe.
 - 7. ANSI A21.51; Ductile-Iron Pipe, Centrifugally Cast, in Metal Molds or Sand-Lined Molds for Water or Other Liquids.
 - 8. ANSI B1.1; Unified Inch Screw Threads.
 - 9. ANSI B2.1; Pipe Threads.
 - 10. ANSI B16.1; Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250 and 800.
 - 11. ANSI B16.3; Malleable Iron Screwed Fittings Class 150 and 300 lb.
 - 12. ANSI B16.4; Cast Iron Threaded Fittings Class 125 and 250 lb.
 - 13. ANSI B16.5; Pipe Flanges and Flanged Fittings.
 - 14. ANSI B16.9; Factory-Made Wrought Steel Buttwelding Fittings.
 - 15. ANSI B16.10; Face-to-Face and End-to-End Dimensions of Ferrous Valves.
 - 16. ANSI B16.11; Forged Steel Fittings, Socket-Welding and Threaded.
 - 17. ANSI B16.12; Cast-Iron Threaded Drainage Fittings.
 - 18. ANSI B16.18; Cast Copper Alloy Solder Joint Pressure Fittings.
 - 19. ANSI B16.21; Nonmetallic Flat Gaskets for Pipe Flanges.
 - 20. ANSI B16.34; Valves-Flanged and Buttwelding End.

21. ANSI B18.2.1; Square and Hex Bolts and Screws Inch Series Including Hex Cap Screws, and Lag Screws.
22. ANSI B18.2.2; Square and Hex Nuts.
23. ANSI B31.1; Power Piping (Pressure Piping).

B. American Society for Testing and Materials (ASTM):

1. ASTM A 47; Specification for Malleable Iron Castings.
2. ASTM A 48, Specification for Gray Iron Castings.
3. ASTM A 53; Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
4. ASTM A 106; Specification for Seamless Carbon Steel Pipe for High-Temperature Service.
5. ASTM A 126; Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.
6. ASTM A 153; Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
7. ASTM A 181; Specification for Forgings, Carbon Steel, for General-Purpose Piping.
8. ASTM A 183; Specification for Heat-Treated Carbon Steel Track Bolts and Nuts.
9. ASTM A 197; Specification for Cupola Malleable Iron.
10. ASTM A 216; Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High Temperature Service.
11. ASTM A 234; Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
12. ASTM A 278; Specification for Gray Iron Castings for Pressure-Containing Parts for Temperatures up to 650 Degrees F (345 Degrees C).
13. ASTM A 307; Specification for Carbon Steel Externally Threaded Standard Fasteners.
14. ASTM A 395; Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
15. ASTM A 518; Specification for Corrosion-Resistant High Silicon Iron Castings.
16. ASTM A 536; Specification for Ductile Iron Castings.
17. ASTM A 714; Specification for High-Strength Low-Alloy Welded and Seamless Steel Pipe.
18. ASTM A 795; Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use.
19. ASTM B 32; Specification for Solder Metal.
20. ASTM B 61; Specification for Steam or Valve Bronze Castings.
21. ASTM B 62; Specification for Composition Bronze or Ounce Metal Castings.
22. ASTM B 371; Specification for Copper-Zinc-Silicon Alloy Rod.
23. ASTM B 584; Specification for Copper Alloy Sand Castings for General Applications.

C. American Water Works Association (AWWA):

1. AWWA C 100; Cast-Iron Pipe, Fittings.
2. AWWA C 500; Valves and Hydrants.

3. AWWA C 800; Service Lines.
4. Fed. Spec. SS-S-210A Sealing Compound, Preformed Plastic, for Expansion Joints and Pipe Joints (Type 1 Rope Form).
5. Fed. Spec. TT-S-1732 Sealing Compound Pipe Joint and Thread, Lead Free General Purpose.

D. Manufacturer's Standardization Society (MSS) of the Valve and Fittings Industry, MSS-SP-70 and MSS-SP-71.

1.03 SUBMITTALS

A. Product Data: Submittals required for the following items:

1. Valves (and Cocks).
2. Pipe and Fittings.
3. Meters and Gages.

B. Shop Drawings: Submittals required for the following items:

1. Prefabricated/Preinsulated Piping dimensioned layout drawings and installation details

PART 2 PRODUCTS

2.01 MATERIALS

A. Valves, General Requirements: Provide valves of the same basic type, by the same product manufacturer, except where specifically specified otherwise. Each valve shall bear manufacturer's trademark, flow direction indication, and reference symbol indicating conditions for which it is guaranteed. Provide valves of pressure and temperature ratings of not less than the design criteria as applicable to the pipe system components.

1. Bronze Valves: Provide valves with pressure containing parts of materials of minimum physical properties in accordance with the specified Reference Standards.
2. Iron and/or Steel Body Valves: Provide valves conforming to ANSI B16.10 for face-to-face and end-to-end dimensions. Valve design, quality, materials and testing shall conform to MSS-SP-70 and MSS-SP-71; with pressure containing parts also of materials of minimum physical properties in accordance with the specified Reference Standards.
3. Gate and Globe Valves: Provide valves designed for repacking under pressure when fully opened, and equipped with packing suitable for the intended service. When the valve is fully opened, the back seal shall protect both packing and stem threads from the fluid.

B. Pipe Line Support Materials: As specified in Section 15060.

C. Pipe Identification and Valve Marking Materials: As specified in Section 15075.

D. Pipe Insulation: As specified in Section 15080.

2.02 METERS AND GAUGES

A. Thermometers: Straight form, front red appearing mercury tube type in 6-1/2 inch (165 mm) cast aluminum case and one piece clear combination frame/ unbreakable front window and separable socket.

1. Scale in black figures on white background. Scale graduated so as to show system design point temperature at midpoint of scale.
2. Acceptable Manufacturers:
 - a. H. O. Trerice;
 - b. Marsh Instrument.
 - c. Taylor Instrument.
 - d. Weksler Instruments Corporation.
 - e. Or Approved Equal.

B. Pressure Gauges: 4-1/2 inch (88.9 mm) diameter cast aluminum case with a clear glass window and a 1/4-inch (6 mm) outlet socket connected into a brass female end needle valves. Movement via brass milled teeth activated by a tube of phosphor bronze snubbers at pumps.

1. Scale in black figures on white background. Scale shall indicate zero to 1-1/2 times the working pressure in the system in which gauge is installed.
2. Acceptable Manufacturers:
 - a. H. O. Trerice;
 - b. Marsh Instrument.
 - c. Taylor Instrument.
 - d. Weksler Instruments Corporation.
 - e. Or Approved Equal.

2.03 STEAM AND CONDENSATE PIPING, ABOVEGROUND INSIDE STRUCTURE

A. Service Requirements:

1. Low Pressure Steam; maximum operating pressure of 15 psig (103.4 kPa) and maximum operating temperature of 300 degrees F (148.9 degrees C).
2. Condensate Return; maximum operating pressure of 50 psig (344.7 kPa) and maximum operating temperature of 275 degrees F (135 degrees C).

B. Steam Pipe: Seamless Carbon Steel Schedule 40 ASTM A 106. Condensate Pipe: Black Steel Schedule 80 ASTM A 106. Nominal Size 2-inch (50 mm) and Smaller.

1. Joints: Threaded.
2. Nipples: Same as Pipe except Schedule 80.
3. Fittings: Malleable Iron 300 lb. (2068 kPa) Threaded ASTM A 47 and ANSI B16.3.
4. Unions: Malleable Iron 300 lb. (2068 kPa) Threaded, Ground Joint Bronze to Iron ASTM A 197 and ANSI B2.1.

5. Thread Lubricant: Graphite/Oil Compound or Polytetrafluoroethylene (PTFE) Tape. On Male Threads ONLY.
 6. Gate Valves: Class 150 Solid Bronze ASTM B 62, Block Pattern, Screw-in Bonnet, Rising Stem, Solid Wedge, Threaded Ends; NIBCO Fig. T-131, or approved equal.
 7. Globe Valves: Class 150 Solid Bronze ASTM B 62, Rising Stem, Integral Seat, Renewable Disc, TFE Seat Disc, Threaded Ends; NIBCO Fig. T-235-Y, or approved equal.
 8. Check Valves: Class 150 Solid Bronze ASTM B 62, Horizontal Swing, Regrinding Type, Y-Pattern, Renewable Disc and Hinge Pin, TFE Seat Disc, Threaded Ends; NIBCO Fig. T-433-Y, or approved equal.
 9. Strainers: Class 250 Semi-Steel Body ASTM A 278 Class 30, 316 S.S. 20 Mesh (.033 in. Openings) Removable Screen, Threaded Cap with Blow-Off, Threaded Ends; Sarco or approved equal.
- C. Steam Pipe: Seamless Carbon Steel Schedule 40 ASTM A 106. Condensate Pipe: Black Steel Schedule 80 ASTM A 106. Nominal Size 2-1/2 in. (65 mm) and Larger.
1. Joints: Welded.
 2. Fittings: Wrought Carbon Steel Standard Weight Welding ASTM A 234 Grade WPB or WPC and ANSI B16.9.
 3. Unions: Forged Carbon Steel Welding - Neck 150 lb. (1034Kpa) Raised-Face Flanges ASTM A 181 and ANSI B16.1.
 4. Gaskets: 1/16 in. (1.6 mm) Thick Non-Mettalic Composition ANSI B16.21.
 5. Bolts: Carbon Steel Hex Bolts and Nuts ASTM A 307 Grade B.
 6. Gate Valves: Class 150 Cast Steel OS & Y, Bolted Bonnet, Rising Stem, Flexible Wedge, Universal Trim, Raised-Face Flanged Ends, ASTM A 216 Grade WCB and ANSI B16.34; NIBCO, or approved equal.
 7. Globe Valves: Class 150 Cast Steel OS & Y, Bolted Bonnet, Rising Stem, Universal Trim, Raised-Face Flanged Ends, ASTM A 216 Grade WCB and ANSI B16.34; NIBCO, or approved equal.
 8. Check Valves: Class 150 Cast Steel Swing Check, Bolted Bonnet, Universal Trim, Valves: Raised-Face Flanged Ends, ASTM A 216 Grade WCB and ANSI B16.34; NIBCO, or approved equal.
 9. Strainers: Class 125 cast iron Body ASTM A 278 Class 30, 316 S.S. 3/64 in. (4.8 mm) Perforations Removable Screen, Bolted Cap with Blow-Off.
 10. Raised-Face Flanged Ends; arco, or approved equal.
- D. Testing: Hydrostatic at 200 psig (1379 kPa).
1. Locate test pressure source on upstream sides on lines containing control valves and set valves in open position for test duration.
 2. Isolate in-line items that may be damaged by test pressures.
 3. Maintain test pressure to within 3 psi (20.7 kPa) of initial test pressure, without introduction of additional pressure, until an examination is made to determine each joint and connection leak free, but in no case less than four hours actual test time.

- E. Cleaning: After testing perform system flushing using hot water and chemical solution as recommended by Oakite Products, Inc., Pennsalt Chemicals Corp., or Bird-Archer Co., or approved equal. Flush system to remove sediment (thread lubricant, oil, loose mill scale and other extraneous deposits caused by assembly methods).
 - 1. System piping and heat generating equipment cleaning may be performed as one operation.
 - 2. Following system cleaning flush out entire system with clean hot water rinse until system is free of sediment and cleaning solution residue.

PART 3 EXECUTION

3.01 PREPARATION

- A. Field Measurement: The Drawings are in general indicative of the Work, with symbols and notations for clarity. However, the Drawings are not an exact representation of all conditions involved, therefore, layout piping to suit actual field measurements.
 - 1. No extra compensation will be made for Work due to difference between indicated and actual dimensions.
 - 2. Submit to the COR for approval, details of proposed departures necessitated by field conditions or other causes.
- B. Interferences: Layout piping systems to compensate for structural interferences, to preserve headroom, and not to interfere with openings, passageways and equipment. Do not install piping with joints and fittings over motors, switchboards, panels, or similar electrical apparatus.

3.02 INSTALLATION

- A. General Requirements: The schematic drawings do not necessarily indicate every piping size or alignment. Provide the required pipe sizes, fittings, adapters, etc. as required to construct complete piping systems.
 - 1. Install piping concealed in those areas of the structures having hung ceilings and exposed in all other areas, except where indicated otherwise on the Drawings.
 - 2. Clean piping prior to installation and following installation to prepare for painting. Keep open ends of piping and pipe attachment openings on equipment capped or plugged until actual connections.
 - 3. Construct pipe runs from full lengths of pipe using short sections only for runs of less than full pipe length. Make changes in directions of pipe runs with fittings only.
 - 4. Cut pipes accurately to measurements established in the field and assemble in place without springing, forcing, excessive cutting or weakening of the structure.
 - 5. Install unions and flanges in accessible locations and whether indicated or not, install union adjacent to equipment and wherever removal of equipment for repair or replacement is required.
 - 6. Provide reducing fittings where reduction in pipe sizes is necessary. Bushings will not be accepted.

7. Install isolation shutoff valves at inlets and outlets to each piece of equipment.
 8. Pipe Supports Installation: Place and support piping runs as specified in Section 15060.
- B. Exposed Piping: Install exposed piping parallel or perpendicular to the lines of the building structure and to compensate for structural interferences, to preserve headroom, and not to interfere with openings, passageways and equipment.
1. Install piping a sufficient distance from other work to permit clearance of not less than one inch between the piping or insulated piping and adjacent work.
 2. Install piping as close as possible to walls, overhead construction, columns, and similar to facilitate insulating work and removal of piping later.
- C. Thermometer and Gauge Installations:
1. Thermometer in Piping: Provide thermometer with 3/4-inch (20 mm) NPT separable socket of noncorrosive material and with 2 3/4-inch (70mm) extension neck and stem of a length to reach the center line of the pipe.
 2. Pressure Gauges in Piping: Provide pressure gauge with 1/4-inch NPT (6 mm) separable socket of noncorrosive material and with 1/4-inch (6 mm) brass nipple for installation of gauge cock.

3.03 PIPE JOINING

- A. General Requirements: Exercise care when making pipe joints and make joints in accordance with the pipe material manufacturer's recommendations and the following additional requirements.
1. In each instance of pipe joining, those portions of pipes involved must be absolutely clean just prior to assembly.
 2. If a joint is extremely difficult to assemble or is not completely sealed, disassemble the joint and correct the difficulty if possible. Remake the joint using new materials when necessary.
- B. Ferrous Metal Piping Joints: Cut pipe ends square, deburr and ream to size of original bore.
1. Threaded: Cut threads to standard gauge depth and length and clean threads free of oil and cuttings. Provide thread lubricant as specified to aid in joint lubrication and sealing in joining operation.
 2. Welded: Responsibility for quality of welding, competency of welding operators and their ability to make sound welds rests with the Contractor. Technique of welding employed, appearance and quality of welds made and methods used in correcting defective work shall conform to requirements of ANSI B31.1 and its Supplements.
 3. Flanged: Face accurately, install gaskets and draw up square and tight to ensure full gasket flow and seal.
 4. O-ring Push Joints in accordance with manufacturers recommended installation practices.

3.04 FIELD QUALITY CONTROL

- A. General Requirements: Conduct tests specified under Piping System Specifications so that each piping system installed in the Project is tested to the COR's satisfaction.
1. Provide tools, materials (including clean water), apparatus and instruments necessary for piping system testing.
 2. Conduct tests of every kind in the presence of and to the satisfaction of the COR.
 3. Free piping systems of trapped air for tests involving water.
 4. Perform tests involving water in the test only when there is no danger of water freezing during the test time period.
 5. Repair and Retest: When a piping system fails to meet test requirements specified herein, conform to the following:
 - a. Determine source or sources of leakage.
 - b. Repair or replace defective material and if a result of improper workmanship, correct such.
 - c. Conduct additional tests to demonstrate that piping system meets specified test requirements.
 - d. Perform repair and retest work at no increase in Contract Price.
 6. Accuracy Proof: Furnish acceptable proof to the COR that testing apparatus, pressure gauges, etc. have been recently checked and calibrated, as applicable, prior to use on this Project.
 7. Notification: Give the COR a minimum of three days advance notice of the times when piping system acceptance testing will be conducted.

END OF SECTION

SECTION 15186

STEAM AND STEAM CONDENSATE SPECIALTIES

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: The work specified in this Section consists of providing the specialties for the steam and steam condensate systems.
- B. Related Sections:
 - 1. Basic Mechanical Materials and Methods: Section 15050.

1.02 REFERENCES

- A. American Society of Mechanical Engineers (ASME):
 - 1. ASME BPV VIII; Boiler and Pressure Vessel Code, Section VIII.
- B. American Society of Testing Materials (ASTM):
 - 1. ASTM A 126; Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
 - 2. ASTM A 395; Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
 - 3. ASTM B 62; Specification for Composition Bronze or Ounce Metal Castings.
- C. National Electrical Manufacturers Association (NEMA):
 - 1. Standards as apply to specified Products.

1.03 SUBMITTALS

- A. Product Data: Submittals required for the following items:
 - 1. Steam Air Vents
 - 2. Steam Traps

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the types of products specified in this Section with a minimum of three years of documented experience.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site in shipping containers with labeling in place. Inspect for damage.

1.06 MAINTENANCE

- A. Extra Materials: Provide two service kits for each size and type of steam trap.

PART 2 PRODUCTS

2.01 STEAM AIR VENTS

- A. Air Vent (AV): ASTM B 62 brass body and cap, balanced pressure type, stainless steel or bronze alloy bellows, stainless steel valve and seat. Access to internal parts without disturbing piping.
 - 1. Rating: 125 psig (861.8 Kpa) WSP.
 - 2. Acceptable Manufacturers:
 - a. Spirax Sarco, Inc.; Model T202 ((VS Series))
 - b. Armstrong International, Inc.
 - c. Or Approved Equal

2.02 STEAM TRAPS

- A. Float and Thermostatic Steam Traps (FT): ASTM A 126 Cast iron body, bolted cover, threaded connections, stainless steel seat and valve, stainless steel lever mechanism, stainless steel or bronze bellows type air vent, stainless steel float. Access to internal parts without disturbing piping, and with bottom drain plug.
 - 1. Rating: 15 psig, 125 psig (103.4 Kpa, 861.8 Kpa) WSP (sized at 1/4" PSIG pressure drop).
 - 2. Acceptable Manufacturers:
 - a. Spirax Sarco, Inc.;
 - b. Armstrong International, Inc.
 - c. ITT Hoffman, Division of ITT Fluid Handling.
 - d. Nicholson Steam Trap, Inc., Division of Watts Industries.
 - e. Or Approved Equal.

- B. Automatic Pump Traps(APT): ASTM A395 SG iron body, bolted cover, threaded connections with stainless steel internal parts. Access to internal parts without disturbing piping, and with bottom drain plug.
 - 1. Rating: 200 psig(1379Kpa)
 - 2. swing type inlet check valve and ball type outlet check valve.
 - 3. Acceptable Manufacturers
 - a. Spirax Sarco, Inc.;
 - b. Armstrong International, Inc.
 - c. ITT Hoffman, Division of ITT Fluid Handling.
 - d. Nicholson Steam Trap, Inc., Division of Watts Industries.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install specialties in accordance with manufacturer's instructions.
- B. Steam Traps:
 - 1. Provide minimum 3/4 inch (20 mm) size unless otherwise indicated on the drawings.
 - 2. Remove thermostatic elements from steam traps during start-up and until system has been operated and dirt pockets are cleaned of sediment and scale.
- C. Safety Relief Valves:
 - 1. Rate for pressure upstream of pressure reducing station, and for full reducing valve capacity.
 - 2. Provide drip pan elbow with drain connection to nearest floor drain.
 - 3. Terminate relief valves to outdoors 2 feet (.6 m) minimum above roof.

END OF SECTION

SECTION 15212

HIGH PURITY COMPRESSED AIR PIPING SYSTEM

PART 1 GENERAL

A. SUMMARY

B. Section Includes: The work specified in this Section consists of constructing the high purity compressed air piping systems including the basic control devices within the piping systems.

C. Related Sections:

1. Basic Mechanical Materials and Methods: Section 15050.
2. Supports, Anchors, and Seals: Section 15060.

1.02 REFERENCES

A. American National Standards Institute (ANSI):

1. ANSI B2.1; Pipe Threads.
2. ANSI B16.3; Malleable Iron Screwed Fittings Class 150 and 300 lb.
3. ANSI B16.10; Face-to-Face and End-to-End Dimensions of Ferrous Valves.
4. ANSI B16.18; Cast Copper Alloy Solder Joint Pressure Fittings.
5. ANSI B16.22; Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
6. ANSI B16.26; Cast Copper Alloy Fittings for Flared Copper Tubes.

B. American Society for Testing and Materials (ASTM):

1. ASTM A 47; Specification for Malleable Iron Castings.
2. ASTM A 53; Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
3. ASTM A 197; Specification for Cupola Malleable Iron.
4. ASTM B 32; Specification for Solder Metal.
5. ASTM B 62; Specification for Composition Bronze or Ounce Metal Castings.
6. ASTM B 88; Specification for Seamless Copper Water Tube.
7. ASTM B 584; Specification for Copper Alloy Sand Castings for General Applications.

C. Manufacturer's Standardization Society (MSS) of the Valve and Fittings Industry, MSS-SP-70 and MSS-SP-71.

D. Uniform Standard Specifications for Public Works Construction (MAG)

1.03 SUBMITTALS

A. Product Data: Submittals required for the following items:

1. Valves (and Cocks).
2. Piping and Fittings.
3. Gages.

4. Filters.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Valves, General Requirements: Provide valves of the same basic type, by the same product manufacturer, except where specifically specified otherwise. Each valve shall bear manufacturer's trademark, flow direction indication, and reference symbol indicating conditions for which it is guaranteed. Provide valves suitable for 125 psi (856 kPa) and a minimum of 100 degrees F. (38 degrees C.). Valves may have threaded end connections for connections between bronze valves and copper tubing.
 - 1. Bronze Valves: Provide valves with pressure containing parts of materials of minimum physical properties in accordance with the specified Reference Standards.

2.02 PIPING SYSTEM SPECIALTIES

- A. Flexible Connectors: Connector construction of corrugated bronze or stainless steel inner liner covered by wire braid of same alloy.
 - 1. End connections threaded on 2-1/2-inch (65 mm) and smaller diameters, and flanged on three inch and larger diameters.
 - 2. Connector length sized for 2-1/2 times nominal pipe diameter of piping.

2.03 GAUGES

- A. Pressure Gauges: Provide single style pressure gauge for water with 4 1/2 (112.5 mm) diameter dial, brass or aluminum case, bronze tube, gage cock, pressure snubber and siphon. Provide scale range suitable for intended service.

2.04 COMPRESSED AIR PIPING, ABOVEGROUND INSIDE STRUCTURE

- A. Service Requirements:
 - 1. Compressed Air; maximum operating pressure of 125 psig (861.7mm) and maximum operating temperature of 100 degrees F. (38.1 degrees C.)
- B. Pipe: Type L copper, drawn ASTM B88. Piping shall be cleaned for oxygen use.
 - 1. Joints: Silver solder braised
 - 2. Fittings: Cast copper alloy flare-type ANSI B16.26
 - 3. Unions: Cast bronze ANSI B16.18 or wrought copper ANSI B16.22 sweat type.
 - 4. Valves and Accessories:
 - a. Ball Valves: Blowout proof stem, 600 WOG/150 PSI S-steam, in-line disassembly design, bronze body and trim ASTM B584, full port, TFE seat. Two position handle.
- C. Testing: Compressed air at 200 psig. (1378.8 kPa)
 - 1. Disconnect equipment and inline devices prior to testing to avoid damage by test pressures.

2. Apply test pressure and conduct soap suds solution test/examination to determine each joint and connection leak free.
3. Testing considered successful when test pressure is maintained for 24 hours continuously with sources of pressure isolated or disconnected. Allowable pressure drop is one psig, which includes changes in temperature in system.

PART 3 EXECUTION

3.01 PREPARATION

- A. Field Measurement: The Drawings are in general indicative of the Work, with symbols and notations for clarity. However, the Drawings are not an exact representation of all conditions involved, therefore, layout piping to suit actual field measurements.
 1. No extra compensation will be made for Work due to difference between indicated and actual dimensions.
 2. Submit to the COR for approval, details of proposed departures necessitated by field conditions or other causes.
- B. Interferences: Layout piping systems to compensate for structural interferences, to preserve headroom, and not to interfere with openings, passageways and equipment. Do not install piping with joints and fittings over motors, switchboards, panels, or similar electrical apparatus.

3.02 INSTALLATION

- A. General Requirements: The schematic drawings do not necessarily indicate every piping size or alignment. Provide the required pipe sizes, fittings, adapters, etc. as required to construct complete piping systems.
 1. Install piping concealed in those areas of the structures having hung ceilings and exposed in all other areas, except where indicated otherwise on the Drawings.
 2. Clean piping prior to installation and following installation to prepare for painting. Keep open ends of piping and pipe attachment openings on equipment capped or plugged until actual connections.
 3. Construct pipe runs from full lengths of pipe using short sections only for runs of less than full pipe length. Make changes in directions of pipe runs with fittings only.
 4. Cut pipes accurately to measurements established in the field and assemble in place without springing, forcing, excessive cutting or weakening of the structure.
 5. Install unions in accessible locations and whether indicated or not, install union adjacent to equipment and wherever removal of equipment for repair or replacement is required.
 6. Provide dielectric unions at points of connection of copper tubing and piping to ferrous metal piping or equipment.
 7. Provide reducing fittings where reduction in pipe sizes is necessary. Bushings will not be accepted.
 8. Install ball valves at inlets and outlets to each piece of equipment.

9. Pipe Supports Installation: Place and support piping runs as specified in Section 15060.
 10. Where it becomes necessary to use short radius fittings because of space limitations, do so only with prior approval of the COR.
- B. Exposed Piping: Install exposed piping parallel or perpendicular to the lines of the building structure and to compensate for structural interferences, to preserve headroom, and not to interfere with openings, passageways and equipment.
1. Install piping a sufficient distance from other work to permit clearance of not less than one inch between the piping or insulated piping and adjacent work.
 2. Install piping as close as possible to walls, overhead construction, columns, and similar to facilitate insulating work and removal of piping later.

3.03 PIPE JOINING

- A. General Requirements: Exercise care when making pipe joints and make joints in accordance with the pipe material manufacturer's recommendations and the following additional requirements.
1. In each instance of pipe joining, those portions of pipes involved must be absolutely clean just prior to assembly.
 2. If a joint is extremely difficult to assemble or is not completely sealed, disassemble the joint and correct the difficulty if possible. Remake the joint using new materials when necessary.
- B. Copper Tubing and Pipe Joints: Cut tubing and piping ends square, deburr and ream to size of original bore.
1. Flared: Cut tubing and piping ends square, deburr and ream to size of original bore. Finished joints shall show evenness of flaring and proper seating of joining parts.

3.04 FIELD QUALITY CONTROL

- A. General Requirements: Conduct tests specified under Piping System Specifications so that each piping system installed in the Project is tested to the COR's satisfaction.
1. Provide tools, materials (including clean water), apparatus and instruments necessary for piping system testing.
 2. Conduct tests of every kind in the presence of and to the satisfaction of the COR.
 3. Free piping systems of trapped air for tests involving water.
 4. Repair and Retest: When a piping system fails to meet test requirements specified herein, conform to the following:
 - a. Determine source or sources of leakage.
 - b. Repair or replace defective material and if a result of improper workmanship, correct such.
 - c. Conduct additional tests to demonstrate that piping system meets specified test requirements.
 - d. Perform repair and retest work at no increase in Contract Price.

5. Accuracy Proof: Furnish acceptable proof to the COR that testing apparatus, pressure gauges, etc. have been recently checked and calibrated, as applicable, prior to use on this Project.
6. Notification: Give the COR a minimum of three days advance notice of the times when piping system acceptance testing will be conducted.

END OF SECTION

SECTION 15214

NITROGEN PIPING SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: The work specified in this Section consists of constructing the nitrogen piping systems including the basic control devices within the piping systems.
- B. Related Sections:
 - 1. Basic Mechanical Materials and Methods: Section 15050.
 - 2. Supports, Anchors, and Seals: Section 15060.
 - 3. Mechanical Identification: Section 15075.

1.02 REFERENCES

- A. American National Standards Institute (ANSI):
 - 1. ANSI B16.10; Face-to-Face and End-to-End Dimensions of Ferrous Valves.
 - 2. ANSI B16.18; Cast Copper Alloy Solder Joint Pressure Fittings.
 - 3. ANSI B16.22; Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
 - 4. ANSI B31.3; Chemical Plant and Petroleum Piping and latest applicable addenda for 150 PSI.
- B. American Society for Testing and Materials (ASTM):
 - 1. ASTM B 584; Specification for Copper Alloy Sand Castings for General Applications.
- C. Manufacturer's Standardization Society (MSS) of the Valve and Fittings Industry, MSS-SP-70 and MSS-SP-71.

1.03 SUBMITTALS

- A. Product Data: Submittals required for the following items:
 - 1. Valves
 - 2. Pipe and Fittings.
 - 3. Specialty Valves.

PART 2 PRODUCTS

2.01 VALVES:

- A. Vacuum insulated valves, t-pattern or y-pattern.

2.02 METERS AND GAUGES

- A. Thermometers: Straight form, front red appearing mercury tube type in 6-1/2 inch (165 mm) cast aluminum case and one piece clear combination frame/ unbreakable front window and separable socket.
 - 1. Scale in black figures on white background. Scale graduated so as to show system design point temperature at midpoint of scale.
 - 2. Acceptable Manufacturers:
 - a. H. O. Trerice; Model No. 4350.
 - b. Marsh Instrument.
 - c. Taylor Instrument.
 - d. Weksler Instruments Corporation.
 - e. Or Approved Equal.
- B. Pressure Gauges: 3-1/2 inch (90 mm) diameter cast aluminum case with a clear glass window and a 1/4-inch outlet socket connected into a brass female end gauge cock. Movement via brass milled teeth activated by a tube of phosphor bronze.
 - 1. Scale in black figures on white background. Scale shall indicate zero to 1-1/2 times the working pressure in the system in which gauge is installed.
 - 2. Acceptable Manufacturers:
 - a. H. O. Trerice; Model No. 601.
 - b. Marsh Instrument.
 - c. Taylor Instrument.
 - d. Weksler Instruments Corporation.
 - e. Or Approved Equal.

2.03 SPECIALTY VALVES

- A. Solenoid Valves: Two way valve, 110 volt power, rated to 210 degrees (99.7 degrees C.) fluid and 200 psi (1379 kPa), stainless steel body. Normally closed or normally open, depending on duty.
 - 1. Acceptable Manufacturers:
 - a. ASCO.
 - b. Hays.
 - c. Or Approved Equal.

2.04 GAS PIPING TYPE NO.1, ABOVEGROUND INSIDE STRUCTURE

- A. Service Requirements:

1. Nitrogen; maximum operating pressure of 150 psig (1034 kPa) and maximum operating temperature of 100 degrees F. (38.0 degrees C.)
- B. Pipe: Type K Copper, Drawn ASTM B 88.. Nominal Size 2 in. (50 mm) and Smaller.
 1. Joints: Brazed.
 2. Nipples: Same as Pipe.
 3. Fittings: "Swagelok: Compression Fittings.
 4. Unions: Cast Bronze ANSI B16.18 or Wrought Copper ANSI B16.22 Sweat Type.
 5. Ball Valves: Blowout Proof Stem, 600 PSI WOG/150 PSI S-steam, In-Line Disassembly Design, Bronze Body and Trim ASTM B 584, Full Port, TRE Seat; NIBCO Fig. T-595-Y Threaded.
- C. Testing: Nitrogen at 200 psig (1378.8 kPa).
 1. Disconnect equipment and inline devices prior to testing to avoid damage by test pressures.
 2. Apply test pressure and conduct soap suds solution test/examination to determine each joint and connection leak free.
 3. Testing considered successful when test pressure is maintained for 24 hours continuously with sources of pressure isolated or disconnected. Allowable pressure drop one psig, which includes changes in temperature in system.

PART 3 EXECUTION

3.01 PREPARATION

- A. Field Measurement: The Drawings are in general indicative of the Work, with symbols and notations for clarity. However, the Drawings are not an exact representation of all conditions involved, therefore, layout piping to suit actual field measurements.
 1. No extra compensation will be made for Work due to difference between indicated and actual dimensions.
 2. Submit to the COR for approval, details of proposed departures necessitated by field conditions or other causes.
- B. Interferences: Layout piping systems to compensate for structural interferences, to preserve headroom, and not to interfere with openings, passageways and equipment. Do not install piping with joints and fittings over motors, switchboards, panels, or similar electrical apparatus.

3.02 INSTALLATION

- A. General Requirements: The schematic drawings do not necessarily indicate every piping size or alignment. Provide the required pipe sizes, fittings, adapters, etc. as required to construct complete piping systems.

1. Install piping concealed in those areas of the structures having hung ceilings and exposed in all other areas, except where indicated otherwise on the Drawings.
 2. Clean piping prior to installation and following installation to prepare for painting. Keep open ends of piping and pipe attachment openings on equipment capped or plugged until actual connections.
 3. Construct pipe runs from full lengths of pipe using short sections only for runs of less than full pipe length. Make changes in directions of pipe runs with fittings only.
 4. Cut pipes accurately to measurements established in the field and assemble in place without springing, forcing, excessive cutting or weakening of the structure.
 5. Install unions and flanges in accessible locations and whether indicated or not, install union adjacent to equipment and wherever removal of equipment for repair or replacement is required.
 6. Provide dielectric unions at points of connection of copper tubing and piping to ferrous metal piping or equipment.
 7. Provide reducing fittings where reduction in pipe sizes is necessary. Bushings will not be accepted.
 8. Install gate valves at inlets and outlets to each piece of equipment.
 9. Pipe Supports Installation: Place and support piping runs as specified in Section 15060.
- B. Exposed Piping: Install exposed piping parallel or perpendicular to the lines of the building structure and to compensate for structural interferences, to preserve headroom, and not to interfere with openings, passageways and equipment.
1. Install piping a sufficient distance from other work to permit clearance of not less than one inch between the piping or insulated piping and adjacent work.
 2. Install piping as close as possible to walls, overhead construction, columns, and similar to facilitate insulating work and removal of piping later.
- C. Thermometer and Gauge Installations:
1. Thermometer in Piping: Provide thermometer with 3/4-inch (20 mm) NPT separable socket of noncorrosive material and with 2 3/4-inch (72.5 mm) extension neck and stem of a length to reach the pipe line center.
 2. Pressure Gauges in Piping: Provide pressure gauge with 1/4-inch NPT separable socket of noncorrosive material and with 1/4-inch brass nipple for installation of gauge cock.

3.03 PIPE JOINING

- A. General Requirements: Exercise care when making pipe joints and make joints in accordance with the pipe material manufacturer's recommendations and the following additional requirements.
1. In each instance of pipe joining, those portions of pipes involved must be absolutely clean just prior to assembly.

2. If a joint is extremely difficult to assemble or is not completely sealed, disassemble the joint and correct the difficulty if possible. Remake the joint using new materials when necessary.

B. Copper Tubing and Pipe Joints: Cut tubing and piping ends square, deburr and ream to size of original bore.

3.04 FIELD QUALITY CONTROL

- A. General Requirements: Conduct tests specified under Piping System Specifications so that each piping system installed in the Project is tested to the COR's satisfaction.
1. Provide tools, materials, apparatus and instruments necessary for piping system testing.
 2. Conduct tests of every kind in the presence of and to the satisfaction of the COR.
 3. Free piping systems of trapped air for tests involving water.
 4. Repair and Retest: When a piping system fails to meet test requirements specified herein, conform to the following:
 - a. Determine source or sources of leakage.
 - b. Repair or replace defective material and if a result of improper workmanship, correct such.
 - c. Conduct additional tests to demonstrate that piping system meets specified test requirements.
 - d. Perform repair and retest work at no increase in Contract Price.
 5. Accuracy Proof: Furnish acceptable proof to the COR that testing apparatus, pressure gauges, etc. have been recently checked and calibrated, as applicable, prior to use on this Project.
 6. Notification: Give the COR a minimum of three days advance notice of the times when piping system acceptance testing will be conducted.

END OF SECTION

SECTION 15725

MODULAR INDOOR AIR-HANDLING UNITS

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes modular air-handling units with coils for indoor installations.
- B. Related Sections include the following:
 - 1. Section 15752 "Humidifiers" for steam grid and evaporative humidifiers not an integral part of modular indoor air-handling units specified in this Section.
 - 2. Section 15860 "Air Cleaning Devices" for air filters to be installed in the modular air-handling units specified in this section.

1.02 SUBMITTALS

- A. Product Data: For each type of modular indoor air-handling unit indicated. Include the following:
 - 1. Certified fan-performance curves with system operating conditions indicated.
 - 2. Certified fan-sound power ratings.
 - 3. Certified coil-performance ratings with system operating conditions indicated.
 - 4. Motor ratings, electrical characteristics, and motor and fan accessories.
 - 5. Material gages and finishes.
 - 6. Filters with performance characteristics.
 - 7. Dampers, including housings, linkages. Operators are to be provided by ATC contractor.
 - 8. Variable Frequency Drive (VFD).
- B. Shop Drawings:
 - 1. Individual unit fabrication drawings including component dimensions and weights.
 - 2. Wiring Diagrams: Power, signal, and control wiring.
- C. Coordination Drawings: Submit with Shop Drawings. Show mechanical-room layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support.

1.03 QUALITY ASSURANCE

- A. Source Limitations: Obtain modular indoor air-handling units through one source from a single manufacturer.
- B. Product Options: Drawings indicate size, profiles, and dimensional requirements of modular indoor air-handling units and are based on the specific system indicated.

- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. NFPA Compliance: Modular indoor air-handling units and components shall be designed, fabricated, and installed in compliance with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."
- E. ARI Certification: Modular indoor air-handling units and their components shall be factory tested according to ARI 430, "Central-Station Air-Handling Units," and shall be listed and labeled by ARI.
- F. Comply with NFPA 70.

1.04 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.
- B. Coordinate size and location of structural-steel support members.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Buffalo Air Handling.
 - 2. CES Group Inc.; Governair, Mammoth, Temtrol, Venmar Ventrol, Webco Divisions.
 - 3. York International Corporation.
 - 4. or Approved Equal
- B. Basis of Design:
 - 1. York International Corporation.

2.02 MANUFACTURED UNITS

- A. Modular indoor air-handling units shall be factory assembled and consist of fans, motor and drive assembly, coils, damper, plenums, filters, condensate pans, mixing dampers, control devices, and accessories.

2.03 CABINET

- A. Materials: Formed and reinforced double-wall insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.

1. Outside Casing: Galvanized steel, 18 gauge thick.
 2. Inside Casing: Galvanized steel 20 gauge thick. Unit shall have solid inside casing with internal insulation for all sections.
- B. Cabinet Insulation: Comply with NFPA 90A or NFPA 90B.
1. Thickness: 2 inches (50 mm).
 2. Thermal Conductivity (k-Value): 0.26 at 75 deg F (0.037 at 24 deg C) mean temperature.
 3. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50, when tested according to ASTM C 411.
 4. Location and Application: Encased between outside and inside casing.
- C. Access Panels and Doors: Same materials and finishes as cabinet, complete with hinges, latches, handles, and gaskets. Inspection and access panels and doors shall be sized and located to allow periodic maintenance and inspections. Provide access panels and doors in the following locations:
1. Fan Section: Doors.
 2. Access Section: Doors.
 3. Discharge and Return Plenums: Doors.
 4. Filter Section: Doors to allow periodic removal and installation of filters.
 5. Economizer Section: Doors
- D. Condensate Drain Pans: Formed sections of stainless-steel sheet complying with requirements in ASHRAE 62. Fabricate pans with slopes in two planes to collect condensate from cooling coils (including coil piping connections and return bends) and humidifiers when units are operating at maximum catalogued face velocity across cooling coil.
1. Double-Wall Construction: Fill space between walls with foam insulation and seal moisture tight.
 2. Drain Connections: One side of pan.
 3. Pan-Top Surface Coating: Elastomeric compound.
 4. Units with stacked coils shall have an intermediate drain pan or drain trough to collect condensate from top coil.
- E. Viewing Windows: Viewing windows shall be provided in all access doors. Windows will be double pane glass, and a minimum size of four inches by eight inches.

2.04 FAN SECTION

- A. Fan-Section Construction: Direct-drive plenum fans, as scheduled, consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, and support structure and equipped with formed-steel channel base for integral mounting of fan, motor, and casing panels. Mount fan with vibration isolation springs.
- B. Centrifugal Fan Housings: Formed- and reinforced-steel panels to make curved scroll housings with shaped cutoff, spun-metal inlet bell, and access doors or panels to allow entry to internal parts and components.
1. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.

2. Performance Class: AMCA 99-2408, Class II.
 3. Horizontal Flanged Split Housing: Bolted construction.
 4. Plug Fans: With steel cabinet. Fabricate without fan scroll and volute housing.
- C. Fan Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum rated fan speed and motor horsepower.
- D. Airfoil-Fan Wheels: Steel construction with smooth-curved inlet flange, heavy backplate, and hollow die-formed airfoil-shaped blades continuously welded at tip flange and backplate; cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws.
- E. Shafts: Statically and dynamically balanced and designed for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.
1. Turned, ground, and polished hot-rolled steel with keyway. Ship with a protective coating of lubricating oil.
 2. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
- F. Grease-Lubricated Shaft Bearings: Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.
1. Ball-Bearing Rating Life L_{50} of 200,000 hours.
 2. Roller-Bearing Rating Life: L_{50} of 200,000 hours.
- G. Vibration Control: Install fans on open-spring vibration isolators having a minimum of 2-inch (50-mm) static deflection.
- H. Fan-Section Source Quality Control:
1. Sound Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Fans shall bear AMCA-certified sound ratings seal.
 2. Factory test fan performance for flow rate, pressure, power, air density, rotation speed, and efficiency. Establish ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

2.05 MOTORS

- A. Torque Characteristics: Sufficient to accelerate driven loads satisfactorily.
- B. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range.
- C. Temperature Rating: 50 deg C maximum temperature rise at 40 deg C ambient for continuous duty at full load (Class A Insulation).
- D. Service Factor: 1.15 for polyphase motors.

- E. Motor Construction: NEMA MG 1, general purpose, continuous duty, Design B.
- F. Bearings: The following features are required:
 1. Ball or roller bearings with inner and outer shaft seals.
 2. Grease lubricated.
 3. Designed to resist thrust loading where belt or other drives produce lateral or axial thrust in motor.
- G. Enclosure Type: The following features are required:
 1. Open dripproof motors if satisfactorily housed or remotely located during operation.
- H. Overload Protection: Built-in, automatically resetting, thermal-overload protection.
- I. Noise Rating: Quiet.
- J. Efficiency: Energy-efficient motors shall have a minimum efficiency as scheduled according to IEEE 112, Test Method B. If efficiency is not specified, motors shall have a higher efficiency than "average standard industry motors" according to IEEE 112, Test Method B.
- K. Nameplate: Indicate ratings, characteristics, construction, special features, and full identification of manufacturer.
- L. Starters, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 16 Sections.
- M. Variable Frequency Drives: See Section 16425 for requirements. VFD shall be mounted on unit and prewired to motor.

2.06 COILS

- A. Coil Sections: Common or individual, insulated, galvanized-steel casings for heating and cooling coils. Design and construct to facilitate removal and replacement of coil for maintenance and to ensure full airflow through coils.
- B. Water Coils: Self-draining coil fabricated according to ARI 410.
 1. Piping Connections: Threaded, on same end.
 2. Tubes: Copper.
 3. Fins: Aluminum.
 4. Fin and Tube Joint: Mechanical bond.
 5. Headers: Seamless copper tube with brazed joints, prime coated.
 6. Frames: Galvanized-steel channel frame,.
 7. Frames: Stainless steel, **0.0625 inch (1.58 mm)**.
 8. Ratings: Design tested and rated according to ASHRAE 33 and ARI 410.
 - a. Working-Pressure Ratings: **200 psig (1380 kPa), 325 deg F (163 deg C)**.
 9. Source Quality Control: Test to **300 psig (2070 kPa)** and to **200 psig (1380 kPa)** underwater.

2.07 DAMPERS

- A. General: Leakage rate, according to AMCA 500, "Laboratory Methods for Testing Dampers for Rating," shall not exceed 2 percent of air quantity at 2000-fpm (10-m/s) face velocity through damper and 4-inch wg (1000-Pa) pressure differential.
- B. Damper Operators: As specified in Division 15 Section "HVAC Instrumentation and Controls."
- C. Low-Leakage Dampers: Double-skin, airfoil-blade galvanized-steel dampers with compressible jamb seals and extruded-vinyl blade edge seals, in opposed -blade arrangement with steel operating rods rotating in sintered bronze or nylon bearings mounted in a single galvanized-steel frame, and with operating rods connected with a common linkage. Leakage rate shall not exceed 5 cfm/sq. ft. (0.22 L/s per sq. m) at 1-inch wg (250 Pa) and 9 cfm/sq. ft. (0.4 L/s per sq. m) at 4-inch wg (1.0 MPa).
- D. Mixing Boxes: Parallel-blade galvanized-steel dampers mechanically fastened to steel operating rod in reinforced, galvanized-steel cabinet. Connect operating rods with common linkage and interconnect linkages so dampers operate simultaneously.

2.08 FILTER SECTION

- A. Filters: Comply with NFPA 90A.
- B. Filter Section: Provide side service filter holding frames arranged for flat orientation, with access doors on both sides of unit.
- C. Refer to Section 15860 Air Cleaning Devices for filter specifications.

2.09 INTERNAL LIGHTING:

- A. Marine type: A marine-type, vapor proof service light shall be provided in the fan segments, all access sections and mixing box sections. Each light will be 100-watt service and shall be wired to an individual switch. Lights will require a 115/1/60-power source that is separate from the main power to the unit. This will permit light operation during periods of shutdown.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in of steam, hydronic, and condensate drainage piping systems and electrical services to verify actual locations of connections before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Concrete Bases: Install floor mounting units on **4-inch- (100-mm-)** high concrete bases. See Section 15050 "Basic Mechanical Materials and Methods" for concrete base materials and fabrication requirements.
- B. Install modular indoor air-handling units with the following vibration control devices. Vibration control devices are specified in Section 15065 "Vibration Isolation".
 - 1. Units with Internally Isolated Fans: Secure units to anchor bolts installed in concrete bases.
 - 2. Floor-Mounted Units: Support on concrete bases using neoprene pads. Secure units to anchor bolts installed in concrete bases.
- C. Arrange installation of units to provide access space around modular indoor air-handling units for service and maintenance.

3.03 CONNECTIONS

- A. Piping installation requirements are specified in Section 15180 "Hydronic Heating and Cooling Piping Systems" and Section 15185 "Steam and Condensate Piping Systems". Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to machine to allow service and maintenance.
- C. Connect piping to modular indoor air-handling units mounted on vibration isolators with flexible connectors.
- D. Connect condensate drain pans using **NPS 1-1/4 (DN 32)**, Type M copper tubing. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.
- E. Hot- and Chilled-Water Piping: Comply with applicable requirements in Section 15180 "Hydronic Heating and Cooling Piping Systems". Connect to supply and return coil tappings with shutoff or balancing valve and union or flange at each connection.
- F. Duct installation and connection requirements are specified in Section 15815 "Metal Ducts" and 15816 "Non-Metal Ducts." Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connections.
- G. Electrical: Comply with applicable requirements in Section 16010 "Basic Electrical Requirements" for power wiring, switches, and motor controls.
- H. Ground equipment according to Section 16060 "Electrical Grounding and Bonding."
- I. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.04 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing.
 - 1. Leak Test: After installation, fill water and steam coils with water and test coils and connections for leaks. Repair leaks and retest until no leaks exist.
 - 2. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, replace with new units, and retest.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.05 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
- B. Final Checks before Startup: Perform the following:
 - 1. Verify that shipping, blocking, and bracing are removed.
 - 2. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
 - 3. Perform cleaning and adjusting specified in this Section.
 - 4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify free fan wheel rotation and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.
 - 5. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.
 - 6. Set zone dampers to fully open position for each zone.
 - 7. Set face-and-bypass dampers to full face flow.
 - 8. Set outside- and return-air mixing dampers to minimum outside-air setting.
 - 9. Comb coil fins for parallel orientation.
 - 10. Install clean filters.
- C. Starting procedures for modular indoor air-handling units include the following:
 - 1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm.
 - 2. Measure and record motor electrical values for voltage and amperage.
 - 3. Manually operate dampers from fully closed to fully open position and record fan performance.
- D. Refer to Section 15950 "Testing, Adjusting, and Balancing" for modular indoor air-handling system testing, adjusting, and balancing.

3.06 ADJUSTING

- A. Adjust damper linkages for proper damper operation.

3.07 CLEANING

- A. Clean modular indoor air-handling units internally, on completion of installation, according to manufacturer's written instructions. Clean fan interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheels, cabinets, and coils entering air face.
- B. After completing system installation and testing, adjusting, and balancing modular indoor air-handling and air-distribution systems, clean filter housings and install new filters.

END OF SECTION 15725

SECTION 15752

HUMIDIFIERS

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes the following type of humidifiers:
 - 1. Steam-injection humidifiers for application on ducted HVAC systems.

1.02 SUBMITTALS

- A. Product Data: Include rated capacities, operating weights, furnished specialties, and accessories.
- B. Shop Drawings: Detail fabrication and installation of humidifiers. Include piping details, plans, elevations, sections, details of components, and dispersion tubes.
 - 1. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.
 - 2. Coordination Drawings: Detail humidifiers and adjacent equipment. Show support locations, type of support, weight on each support, and required clearances.
- C. Maintenance Data: For humidifiers to include in maintenance manuals.

1.03 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with ARI 640, "Standard for Commercial and Industrial Humidifiers."

1.04 COORDINATION

- A. Coordinate location and installation of humidifiers in ducts and air-handling units. Revise locations and elevations to suit field conditions and to ensure proper humidifier operation.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Steam-Injection Humidifiers:
 - a. Armstrong International, Inc.
 - b. Dri-Steam Humidifier Co.
 - c. Herrmidifier Co., Inc.
 - d. Hygromatik, Spirax Sarco, Inc.
 - e. Nortec Industries, Inc.
 - f. Pure Humidifier Co.
 - g. Or Approved Equal

2.02 STEAM-INJECTION HUMIDIFIERS

- A. Description: Steam valve, separator, and short absorption manifold extending across entire width of duct and equipped with mounting brackets for both ends of tube.
- B. Dispersion Tube: ASTM A 666, Type 304 stainless steel, jacketed.
- C. Control Valve: Normally closed valve, with seat and stem matched to deliver required steam flow.
 - 1. Actuator: Electric, modulating, with spring return.
- D. Steam Separator: Separate from control valve.
 - 1. Material: Type 304 stainless steel.
- E. Steam Trap: Inverted-bucket type, sized for maximum condensate flow.
- F. Optional Accessories: Include the following:
 - 1. In-line strainer.
 - 2. Temperature switch to prevent cold operation

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine ducts, air-handling units, and conditions for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in for piping systems to verify actual locations of piping connections before humidifier installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 HUMIDIFIER INSTALLATION

- A. Install with required clearance for service and maintenance.
- B. Seal humidifier dispersion-tube duct penetrations with flange.
- C. Install dispersion tubes pitched to drain condensate back to housing.
- D. Install drip leg upstream from steam trap, a minimum of **12 inches (300 mm)** for proper operation of trap.

3.03 CONNECTIONS

- A. Piping installation requirements are specified in other Section 15185 “Steam and Condensate Piping Systems.” Drawings indicate general arrangement of piping, fittings, and specialties.
 - 1. Install piping adjacent to machine to allow service and maintenance.
 - 2. Install shutoff valve and strainer in humidifier supply line.
 - 3. Install backflow prevention device in humidifier supply line.
 - 4. Connect piping with a minimum of **1-inch (25-mm)** air gap in fill line to prevent backflow into supply line.
- B. Install electrical devices furnished by manufacturer but not specified to be factory mounted.
- C. Ground equipment.
 - 1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.04 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing.
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove malfunctioning units, replace with new units, and retest.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.05 DEMONSTRATION

- A. Train ROICC 's maintenance personnel to adjust, operate, and maintain humidifiers.
 - 1. Train ROICC 's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.

2. Review data in maintenance manuals.
3. Schedule training with ROICC, with at least seven days' advance notice.

END OF SECTION 15752

SECTION 15760

TERMINAL HEATING UNITS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: The work specified in this Section consists of constructing the heating and ventilating equipment systems for the project.
- B. Related Sections:
 - 1. Basic Mechanical Requirements: Section 15050.
 - 2. Supports, Anchors and Seals: Section 15060.
 - 3. Vibration Isolation: Section 15065.
 - 4. Metal Ducts: Section 15815.

1.02 REFERENCES

- A. Air Conditioning and Refrigeration Institute (ARI):
 - 1. ARI 410: Forced-Circulation Air-Cooling and Air-Heating Coils.
- B. National Fire Protection Association (NFPA):
 - 1. NFPA 90A: Standard for the Installation of Air Conditioning and Ventilating Systems.
 - 2. NFPA 90B: Standard for the Installation of Warm Air Heating and Air Conditioning Systems.
- C. Underwriters' Laboratories, Inc. (UL): Listings and Labels shall govern the quality and performance of certain Products as specified herein.

1.03 WARRANTY

- A. Provide a full parts warranty for one year from start-up or substantial completion.

1.04 SUBMITTALS

- A. Product Data: Submittals required for the following items:
 - 1. Unit Heaters
 - 2. Hot Water Heating Coils
 - 3. Electric Unit Heater
- B. Shop Drawings: Submittals required for the following piping systems:
 - 1. Unit Heaters
 - 2. Hot Water Heating Coils
 - 3. Electric Unit Heater

PART 2 PRODUCTS

2.01 MATERIALS

- A. Vibration Isolators: As specified in Section 15065.
- B. Auxiliary Steel, Rods, Anchors and Fasteners: As specified in Section 15060.
- C. Ductwork: As specified in Section 15815.

2.02 HYDRONIC TERMINAL HEATING UNITS

- A. Unit Heaters:
 - 1. Heating Coil: Constructed of seamless copper pressure tubing mechanically bonded to the collars of aluminum fins spaced at 12 fins per inch. Tubes brazed to steel headers and mounted to provide for expansion. Coils guaranteed for safe operation at hot water pressure up to 125 pounds per square inch and 340 degrees F and factory leak tested at 400 PSIG hydrostatic pressure.
 - 2. Fans & Motors: Large face area blade style of aluminum and mechanically fastened to steel hubs. Fans factory tested and dynamically balanced. Fan blades protected with a fan guard of corrosion resistant metal. Motors UL Listed, thermal overload protected, and rated continuous duty by NEMA standards, but capable of operation in 104 degrees F. ambient temperature and permanently lubricated. Motors resiliently mounted to prevent vibration transmission to the building and heat shielded from the heating coil. Motor controls manufacturer's standard for starting and limit control.
 - 3. Horizontal Style Casing: Fabricated from 18 gauge steel minimum with internal reinforcing and threaded hanger rods or pipes for unit suspension mounting. Casing back panel formed into a fan venturi. Casing air discharge fitted with individually adjustable horizontal and vertical deflection louvers for four way applications. Casing finished inside and out with baked-on primer and enamel after cleaning, bonderizing, phosphatizing treatments on the base metals. Final enamel color selected by the Owner.
 - 4. Vertical Style Casing: Fabricated from 16 gauge steel minimum with internal reinforcing and threaded hanger rods or pipes for unit suspension mounting. Fan venturi formed in casing bottom and casing top depressed for motor and fan location. Casing air discharge fitted with radial louvers for air delivery. Casing finished inside and out with baked-on primer and enamel after cleaning, bonderizing, phosphatizing treatments on the base metals. Final enamel in manufacturer's standard color.
 - 5. Controls: Refer to Division 15 Controls and Sequence of Operation.
 - 6. Acceptable Manufacturers
 - a. The Trane Company.
 - b. Dunham Bush; Model H/C.
 - c. Modine Manufacturing Company.
 - d. Or Approved Equal.

- B. Hot Water Heating Coils
1. General: Coil capacities, pressure drops and selection procedures shall be certified in accordance with ARI Standard 410-81
 2. Configuration: Drainable, with threaded plugs [in headers] for drain and vent; threaded plugs in return bends and in headers opposite each tube.
 3. Fins: Continuous aluminum configured plate-fin tube with full fin collars for spacing and maximum fin-tube contact.
 4. Tubes: 5/8-inch O.D. copper (red brass), expanded into the fin collars and header.
 5. Headers: Cast iron with tubes expanded into header, seamless copper tube with silver brazed joints, or prime coated steel pipe with brazed joints.
 6. Casings:
 - a. Low and Medium Pressure: Constructed of 16 gauge, continuous coated galvanized steel with fins recessed into the channels to minimize air bypass. Top and bottom channels shall have holes for mounting purposes.
 7. Acceptable Manufacturers:
 - a. The Trane Company.
 - b. Carrier Corp.
 - c. York.
 - d. McQuay
 - e. Or Approved Equal.
- C. Electric Unit Heaters: Provide unit heaters meeting UL Standard 1025 (When installed as directed by manufacturer) of forced air design and of capacities indicated on the Drawings.
1. Casing: Die-formed heavy-gauge steel finished in high gloss, baked enamel. Supply air drawn and discharged through an outward drawn venturi. Intake louvers stamped in sides of casing and arranged for uniform air distribution across entire heating element. Face mounted outlet louvers individually adjustable from 30 degrees up to 45 degrees down. Casing access through hinged door with quarter-turn fastener locking.
 2. Elements: High mass, all steel, tubular finned design.
 3. Motor and Fan: Totally enclosed, permanently lubricated sealed bearings for five years continuous duty. Fan of axial flow-type designed for quiet efficient operation and direct connected to motor.
 4. Wiring: Designed for single circuit, with elements, motor, and control circuits subdivided with factory fuses to conform to the National Electric Code and UL Standard 1025.
 5. Thermal Overload Protection: Manual reset type for elements and motor if safe operating temperatures are exceeded.
 6. Controls: Contactors and control circuit transformers, where required, factory installed and wired. Built-in fan override provided to purge unit casing of excess heat after unit shutdown. Provide power disconnect for field installation to disconnect ungrounded connectors.
 7. Thermostat: Unit mounted and of heavy duty hydraulic actuating type with a range of 45 degrees F to 90 degrees F and two-stage in operation.

8. Acceptable Manufacturers:
 - a. The Trane Company; Series UHEC.
 - b. Chromalox, Wiegand Industrial Division, Emerson Electric Co.
 - c. Berko, Division of Marley Electric Heating.

PART 3 EXECUTION

3.01 PERFORMANCE

- A. Installation Instructions: Install those Products, as specified previously under PART 2 and not specifically covered for installation herein under PART 3, in strict accordance with manufacturer's installation instructions and at locations indicated on the Drawings.
- B. Equipment Start-Up:
 1. Perform equipment start-up and ensure its proper operation prior to acceptance of work by the Engineer.
- C. Materials and Equipment Exposed to Weather: Provide stainless steel fasteners for both exposed and concealed attachments. Install gaskets and seals, when provided with materials and equipment, to ensure weatherproof installations.

3.02 DUCT INSTALLATION

- A. Ductwork Installation: As specified in Section 15815.

END OF SECTION

SECTION 15815

METAL DUCTS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section includes metal ducts for supply, return, outside, and exhaust air-distribution systems in pressure classes from minus 6- to plus 10-inch wg (minus 1500 to plus 2500 Pa). Metal ducts include the following:
 - 1. Rectangular ducts and fittings.
 - 2. Single-wall, round spiral-seam ducts and formed fittings.
- B. Related Sections include the following:
 - 1. Section 15816 "Nonmetal Ducts" for fibrous-glass ducts, thermoset FRP ducts, thermoplastic ducts, PVC ducts, and concrete ducts.
 - 2. Section 15820 "Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.02 SYSTEM DESCRIPTION

- A. Duct system design, as indicated, has been used to select size and type of air-moving and -distribution equipment and other air system components. Changes to layout or configuration of duct system must provide original design results without increasing system total pressure.

1.03 SUBMITTALS

- A. Shop Drawings: CAD-generated and drawn to scale. Show fabrication and installation details for metal ducts.
 - 1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
 - 2. Duct layout indicating sizes and pressure classes.
 - 3. Elevations of top and bottom of ducts.
 - 4. Dimensions of main duct runs from building grid lines.
 - 5. Fittings.
 - 6. Reinforcement and spacing.
 - 7. Seam and joint construction.
 - 8. Penetrations through fire-rated and other partitions.
 - 9. Equipment installation based on equipment being used on Project.
 - 10. Duct accessories, including access doors and panels.
 - 11. Hangers and supports, including methods for duct and building attachment, and vibration isolation.

- B. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
 - 1. Ceiling suspension assembly members.
 - 2. Other systems installed in same space as ducts.
 - 3. Ceiling- and wall-mounting access doors and panels required to provide access to dampers and other operating devices.
 - 4. Ceiling-mounting items, including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
- C. Welding certificates.
- D. Field quality-control test reports.

1.04 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel," for hangers and supports AWS D1.2, "Structural Welding Code--Aluminum," for aluminum supporting members and AWS D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.
- B. NFPA Compliance:
 - 1. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."
 - 2. NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.02 SHEET METAL MATERIALS

- A. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653/A 653M and having G90 (Z275) coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view. Use G120 coating for ductwork exposed to weather.

- C. Stainless Steel: ASTM A 480/A 480M, Type 304, and having a No. 2D finish for concealed ducts and No. 4 polished finish for exposed ducts in cleanrooms.
- D. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts.
- E. Tie Rods: Galvanized steel, 1/4-inch (6-mm) minimum diameter for lengths 36 inches (900 mm) or less; 3/8-inch (10-mm) minimum diameter for lengths longer than 36 inches (900 mm). Option for galvanized, 1/2 inch conduit per SMACNA.

2.03 SEALANT MATERIALS

- A. Joint and Seam Sealants, General: The term "sealant" is not limited to materials of adhesive or mastic nature but includes tapes and combinations of open-weave fabric strips and mastics.
- B. Joint and Seam Sealer
- C. Sealing System: Seal joints per SMACNA.
- D. Water-Based Joint and Seam Sealant: Flexible, adhesive sealant, resistant to UV light when cured, UL 723 listed, and complying with NFPA requirements for Class 1 ducts.
- E. Solvent-Based Joint and Seam Sealant: One-part, nonsag, solvent-release-curing, polymerized butyl sealant formulated with a minimum of 75 percent solids.
- F. Flanged Joint Mastic: One-part, acid-curing, silicone, elastomeric joint sealant complying with ASTM C 920, Type S, Grade NS, Class 25, Use O.
- G. Flange Gaskets: Butyl rubber or EPDM polymer with polyisobutylene plasticizer.

2.04 HANGERS AND SUPPORTS

- A. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
 - 1. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches (100 mm) thick.
 - 2. Exception: Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches (100 mm) thick.
- B. Hanger Materials: Galvanized sheet steel or threaded steel rod.
 - 1. Hangers Installed in Corrosive Atmospheres: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
 - 2. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for steel sheet width and thickness and for steel rod diameters.

3. Galvanized-steel straps attached to aluminum ducts shall have contact surfaces painted with zinc-chromate primer.
- C. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- D. Trapeze and Riser Supports: Steel shapes complying with ASTM A 36/A 36M.
1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
 2. Supports for Stainless-Steel Ducts: Stainless-steel support materials.

2.05 RECTANGULAR DUCT FABRICATION

- A. Fabricate ducts, elbows, transitions, offsets, branch connections, and other construction according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" and complying with requirements for metal thickness, reinforcing types and intervals, tie-rod applications, and joint types and intervals.
1. Lengths: Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure class.
 2. Deflection: Duct systems shall not exceed deflection limits according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."
- B. Transverse Joints: Prefabricated slide-on joints and components constructed using manufacturer's guidelines for material thickness, reinforcement size and spacing, and joint reinforcement.
1. Available Manufacturers:
 - a. Ductmate Industries, Inc.
 - b. Nexus Inc.
 - c. Ward Industries, Inc.
 - d. Or Approved Equal
- C. Formed-On Flanges: Construct according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," Figure 1-4, using corner, bolt, cleat, and gasket details.
1. Available Manufacturers:
 - a. Ductmate Industries, Inc.
 - b. Lockformer.
 - c. Or Approved Equal
 2. Duct Size: Size per manufacturer's specifications.
 3. Longitudinal Seams: Pittsburgh lock sealed with noncuring polymer sealant.
- D. Cross Breaking or Cross Beading: Cross break or cross bead duct sides 19 inches (480 mm) and larger and 0.0359 inch (0.9 mm) thick or less, with more than 10 sq. ft. (0.93 sq. m) of nonbraced panel area unless ducts are lined.

2.06 ROUND DUCT AND FITTING FABRICATION

- A. Round, Longitudinal and Spiral Lock -Seam Ducts: Fabricate supply ducts according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."

- B. Duct Joints:
1. Ducts up to 20 Inches (500 mm) in Diameter: Interior, center-beaded slip coupling, sealed before and after fastening, attached with sheet metal screws.
 2. Ducts 21 to 72 Inches (535 to 1830 mm) in Diameter: Three-piece, gasketed, flanged joint consisting of two internal flanges with sealant and one external closure band with gasket.
 3. Ducts Larger Than 72 Inches (1830 mm) in Diameter: Companion angle flanged joints per SMACNA "HVAC Duct Construction Standards--Metal and Flexible," Figure 3-2.
 4. Round Ducts: Prefabricated connection system consisting of double-lipped, EPDM rubber gasket. Manufacture ducts according to connection system manufacturer's tolerances.
 - a. Available Manufacturers:
 - 1) Lindab Inc.
 - 2) Or Approved Equal
- C. 90-Degree Tees and Laterals and Conical Tees: Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," with metal thicknesses specified for longitudinal-seam straight ducts.
- D. Diverging-Flow Fittings: Fabricate with reduced entrance to branch taps and with no excess material projecting from fitting onto branch tap entrance.
- E. Fabricate elbows using die-formed, gored, pleated, or mitered construction. Bend radius of die-formed, gored, and pleated elbows shall be 1-1/2 times duct diameter. Unless elbow construction type is indicated, fabricate elbows as follows:
1. Mitered-Elbow Radius and Number of Pieces: Welded construction complying with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," unless otherwise indicated.
 2. Round Mitered Elbows: Welded construction with the following metal thickness for pressure classes from minus 2- to plus 2-inch wg (minus 500 to plus 500 Pa):
 - a. Ducts 3 to 36 Inches (75 to 915 mm) in Diameter: 0.034 inch (0.85 mm).
 - b. Ducts 37 to 50 Inches (940 to 1270 mm) in Diameter: 0.040 inch (1.0 mm).
 - c. Ducts 52 to 60 Inches (1320 to 1525 mm) in Diameter: 0.052 inch (1.3 mm).
 - d. Ducts 62 to 84 Inches (1575 to 2130 mm) in Diameter: 0.064 inch (1.6 mm).
 3. Round Mitered Elbows: Welded construction with the following metal thickness for pressure classes from 2- to 10-inch wg (500 to 2500 Pa):
 - a. Ducts 3 to 26 Inches (75 to 660 mm) in Diameter: 0.034 inch (0.85 mm).
 - b. Ducts 27 to 50 Inches (685 to 1270 mm) in Diameter: 0.040 inch (1.0 mm).
 - c. Ducts 52 to 60 Inches (1320 to 1525 mm) in Diameter: 0.052 inch (1.3 mm).
 - d. Ducts 62 to 84 Inches (1575 to 2130 mm) in Diameter: 0.064 inch (1.6 mm).
 - e.
 4. 90-Degree, 2-Piece, Mitered Elbows: Use only for supply systems or for material-handling Class A or B exhaust systems and only where space restrictions do not permit using radius elbows. Fabricate with single-thickness turning vanes.
 5. Round Elbows 8 Inches (200 mm) and Less in Diameter: Fabricate die-formed elbows for 45- and 90-degree elbows and pleated elbows for 30, 45, 60, and 90

- degrees only. Fabricate nonstandard bend-angle configurations or nonstandard diameter elbows with gored construction.
6. Round Elbows 9 through 14 Inches (225 through 355 mm) in Diameter: Fabricate gored or pleated elbows for 30, 45, 60, and 90 degrees unless space restrictions require mitered elbows. Fabricate nonstandard bend-angle configurations or nonstandard diameter elbows with gored construction.
 7. Round Elbows Larger Than 14 Inches (355 mm) in Diameter: Fabricate gored elbows unless space restrictions require mitered elbows.
 8. Die-Formed Elbows for Sizes through 8 Inches (200 mm) in Diameter and All Pressures 0.040 inch (1.0 mm) thick with 2-piece welded construction.
 9. Round Gored-Elbow Metal Thickness: Same as non-elbow fittings specified above.
 10. Pleated Elbows for Sizes through 14 Inches (355 mm) in Diameter and Pressures through 10-Inch wg (2500 Pa): 0.022 inch (0.55 mm).

PART 3 EXECUTION

3.01 DUCT APPLICATIONS

- A. Static-Pressure Classes: Unless otherwise indicated, construct ducts according to the following:
 1. Supply Ducts (before Air Terminal Units): 4-inch wg (100 Pa).
 2. Supply Ducts (after Air Terminal Units): 2-inch wg (500 Pa).
 3. Return Ducts (Negative Pressure): 3-inch wg (750 Pa).
 4. Exhaust Ducts (Negative Pressure): 3-inch wg (750 Pa) up to exhaust fan suction and (positive pressure) 2-inch wg (500 Pa) from fan discharge to outlet.
- B. All ducts shall be galvanized steel except as follows:
 1. Solvent-Resistant (Fume-Handling) Ducts: Type 304, stainless-steel sheet with No. 4 finish where exposed in cleanroom. Mill finish in unfinished areas.

3.02 DUCT INSTALLATION

- A. Construct and install ducts according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," unless otherwise indicated.
- B. Install round ducts in lengths not less than 12 feet (3.7 m) unless interrupted by fittings.
- C. Install ducts with fewest possible joints.
- D. Install fabricated fittings for changes in directions, size, and shape and for connections.
- E. Install couplings tight to duct wall surface with a minimum of projections into duct. Secure couplings with sheet metal screws. Install screws at intervals of 12 inches (300 mm), with a minimum of 3 screws in each coupling.

- F. Install ducts, unless otherwise indicated, vertically and horizontally and parallel and perpendicular to building lines; avoid diagonal runs.
- G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- H. Install ducts with a clearance of 1 inch (25 mm), plus allowance for insulation thickness.
- I. Conceal ducts from view in finished spaces. Do not encase horizontal runs in solid partitions unless specifically indicated.
- J. Coordinate layout with suspended ceiling, smoke-control dampers, lighting layouts, and similar finished work.
- K. Seal all joints and seams. Apply sealant to male end connectors before insertion, and afterward to cover entire joint and sheet metal screws.
- L. Electrical Equipment Spaces: Route ducts to avoid passing through transformer vaults and electrical equipment spaces and enclosures.
- M. Partition Penetrations: Where ducts pass through interior partitions and exterior walls and are exposed to view, conceal spaces between construction openings and ducts or duct insulation with sheet metal flanges of same metal thickness as ducts. Overlap openings on 4 sides by at least 1-1/2 inches (38 mm).
- N. Protect duct interiors from the elements and foreign materials until building is enclosed.

3.03 SEAM AND JOINT SEALING

- A. Seal duct seams and joints according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for duct pressure class indicated.
 - 1. For pressure classes lower than 2-inch wg (500 Pa), seal transverse joints.
- B. Seal ducts before external insulation is applied.

3.04 HANGING AND SUPPORTING

- A. Support horizontal ducts within 24 inches (600 mm) of each elbow and within 48 inches (1200 mm) of each branch intersection.
- B. Support vertical ducts at maximum intervals of 16 feet (5 m) and at each floor.
- C. Install upper attachments to structures with an allowable load not exceeding one-fourth of failure (proof-test) load.
- D. Install concrete inserts before placing concrete.

- E. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
 - 1. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches (100 mm) thick.

3.05 CONNECTIONS

- A. Make connections to equipment with flexible connectors according to Division 15 Section "Duct Accessories."
- B. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.06 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections according to SMACNA's "HVAC Air Duct Leakage Test Manual" and prepare test reports:
 - 1. Test all medium pressure ductwork and 15% of low pressure ductwork.
 - 2. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
 - 3. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If pressure classes are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure. Give seven days' advance notice for testing.
 - 4. Maximum Allowable Leakage: Comply with requirements for Leakage Class 6 for pressure classes from 2- to 10-inch wg (500 to 2500 Pa).
 - 5. Remake leaking joints and retest until leakage is equal to or less than maximum allowable.
 - 6. After Leakage tests have been completed, notify the commissioning agent for verification of test.

3.07 CLEANING NEW SYSTEMS-Clean Rooms Only

- A. All duct work serving cleanrooms shall be cleaned in fabrication shop and wrapped in protective plastic wrap, including open ends, to maintain cleanliness.
- B. Mark position of dampers and air-directional mechanical devices before cleaning, and perform cleaning before air balancing.
- C. Use service openings, as required, for physical and mechanical entry and for inspection.
 - 1. Create other openings to comply with duct standards.
 - 2. Disconnect flexible ducts as needed for cleaning and inspection.
 - 3. Remove and reinstall ceiling sections to gain access during the cleaning process.
- D. Vent vacuuming system to the outside. Include filtration to contain debris removed from HVAC systems, and locate exhaust down wind and away from air intakes and other points of entry into building.

- E. Clean the following metal duct systems by removing surface contaminants and deposits:
1. Air outlets and inlets (registers, grilles, and diffusers).
 2. Supply and return fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
 3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
 4. Coils and related components.
 5. Return-air ducts, dampers, and actuators except in ceiling plenums and mechanical equipment rooms.
 6. Supply-air ducts, dampers, actuators, and turning vanes.
- F. Mechanical Cleaning Methodology:
1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
 2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
 3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
 4. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.

END OF SECTION

SECTION 15816
NONMETAL DUCTS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section includes the following:
 - 1. Fiberglass reinforced ducts (FRP) with FM Approval without internal sprinklers.
- B. Related Sections include the following:
 - 1. Section 15820 "Duct Accessories" for dampers, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.02 SYSTEM DESCRIPTION

- A. Duct system design, as indicated, has been used to select size and type of air-moving and -distribution equipment and other air system components. Changes to layout or configuration of duct system must be specifically approved, in writing, by the COR. Accompany requests for layout modifications with calculations showing that proposed layout will provide original design results without increasing system total pressure.

1.03 SUBMITTALS

- A. Product Data: For the following:
 - 1. Fiberglass Reinforced Plastic (FRP) materials – FM Approved for use without sprinklers.
- B. Shop Drawings: Drawn to 1/4 inch equals 1 foot (1:50) scale. Show fabrication and installation details for nonmetal ducts.
 - 1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
 - 2. Duct layout indicating sizes and pressure classes.
 - 3. Elevations of top and bottom of ducts.
 - 4. Dimensions of main duct runs from building grid lines.
 - 5. Fittings.
 - 6. Reinforcements and spacing.
 - 7. Seam and joint construction.
 - 8. Penetrations through fire-rated and other partitions.
 - 9. Equipment installation based on equipment being used on Project.
 - 10. Duct accessories, including access doors and panels.
 - 11. Hangers and supports, including methods for duct and building attachment, vibration isolation.
- C. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Ceiling suspension assembly members.
2. Other systems installed in same space as ducts.
3. Ceiling- and wall-mounting access doors and panels required to provide access to dampers and other operating devices.
4. Ceiling-mounting items, including lighting fixtures, diffusers, grilles, sprinklers, and access panels.

1.04 QUALITY ASSURANCE

- A. Underwriters Laboratories Standard U.L. 181
- B. FM 4922 Approved use for fume and smoke removal without interrupters or automatic sprinkler protection.
- C. FM 4910 Approved to exceed all requirements for smoke damage, fire propagation and corrosion damage and is acceptable for cleanroom use.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.02 FIBERGLASS REINFORCED PLASTIC DUCTS (FRP)

- A. Available Manufacturers:
 1. Mark VIII Duct System, ATS, Inc.
 2. Or Approved Equal
- B. Fabrication:
 1. Maximum Operating Static Pressure: 10-inch wg (2500 Pa).
- C. Fitting Fabrication:
 1. Internal beaded slip collar connection system
 2. Round Elbows: Smooth sweep elbow construction with centerline radius at least 1.5 times the diameter.
 3. Branch Connections to Main Ducts: 45 degrees from centerlines of main ducts.
 4. Offsets: 45 degrees from centerlines of straight ducts.

- D. Supports and Hangers: Galvanized steel.
 - 1. Vertical Ducts: Structural channels and clamps under 1/2-inch (13-mm) FRP flanges on outside of ducts.
 - 2. Horizontal Ducts: Steel split rings and rod hangers. Rings shall not compress ducts when closed.
- E. Drains: PVC drain pockets with 1-inch (25-mm) threaded PVC pipe connections.
- F. Flexible Connectors:
 - 1. Material: Hypalon.
 - 2. Length: 4 inches (100 mm) between both parts to be connected, with enough slack material to prevent vibration transmission when system is in operation.
 - 3. Clamps: Two stainless-steel, gear-drive bands.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install ducts with fewest possible joints.
- B. Install ducts, unless otherwise indicated, vertically and horizontally and parallel and perpendicular to building lines; avoid diagonal runs, unless indicated on drawings.
- C. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- D. Install ducts with a clearance of 1 inch (25 mm).
- E. Conceal ducts from view in finished spaces. Do not encase horizontal runs in solid partitions unless specifically indicated.
- F. Non-Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls and are exposed to view, conceal spaces between construction openings and ducts with sheet metal flanges of same metal thickness as ducts. Overlap opening on 4 sides by at least 1-1/2 inches (38 mm).
- G. Install FRP ducts and fittings according to Manufacturer's recommendations.
- H. Install FRP ducts so that no metals penetrate duct system.
 - 1. Support vertical ducts at every floor and at roof. Support horizontal ducts according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."
 - 2. Support exhaust fans, fume hoods, and heavy accessories independent of ducts.
 - 3. Install flexible connectors with enough slack to prevent vibration transmission when fan is in operation.
 - 4. Install and brace rainstack exhaust terminals with stays firmly anchored to roof.
 - 5. Slope exhaust ducts back to fume hoods.
 - 6. Install penetrations through roof with flashing and counterflashing.

- I. Mount accessories according to manufacturer's instructions."
 - 1. Reinforce and support equipment and duct accessories for additional weight without damage to ducts.
 - 2. Install volume-control dampers or blast gates and operators on same sleeves or mounting plates and allow full 90-degree quadrant movement.
 - 3. Connect ducts to equipment using manufacturer's recommendations.
- J. Install concrete inserts before placing concrete.
- K. Building Attachments: Install powder-actuated concrete fasteners after concrete is placed and completely cured.
- L. Duct Attachments: Support horizontal ducts with trapeze-type hangers.
- M. Hangers: Suspend duct attachments from building attachments with one of the following hanger types:
 - 1. Galvanized sheet metal strips, a minimum of 0.034 by 1 inch (0.85 by 25 mm) wide.
 - 2. Galvanized-steel rods, 1/4 inch (6 mm) in diameter, threaded along entire length.
 - 3. Galvanized-steel wire, 0.108 inch (2.8 mm) minimum.
- N. Attach hangers to joints and reinforcing channels that occur within required hanger spacing. Attach hangers to transmit load to sides and bottom channels and no more than 6 inches (150 mm) from sides of ducts.
- O. Support equipment and metal duct components and accessories independent of ducts.
- P. Support terminal components separately.

3.02 CLEANING

- A. Clean ducts according to manufacturer's recommendations.

END OF SECTION

SECTION 15817

HVAC CASINGS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes HVAC casings for field-erected air-handling unit (AHU-11, AHU-12) air intake plenums.

1.03 DEFINITIONS

- A. Thermal Conductivity and Apparent Thermal Conductivity (k-Value): As defined in ASTM C 168. In this Section, these values are the result of the formula $\text{Btu} \times \text{in.}/\text{h} \times \text{sq. ft.} \times \text{degrees F}$ ($\text{W}/\text{m} \times \text{K}$) at temperature differences specified. Values are expressed as Btu (W).
 - 1. Example: Apparent Thermal Conductivity (k-Value): 0.26 (0.037).

1.04 SUBMITTALS

- A. Product Data: For factory-fabricated casings, sealant materials, and interior insulation materials.
- B. Shop Drawings: Include plans, elevations, sections, components, and attachments to other work. Show fabrication and installation details of the following:
 - 1. Reinforcement and spacing.
 - 2. Seam and joint construction.
 - 3. Access doors, including frames, hinges, and latches.
 - 4. Hangers and supports, including methods for building attachment, vibration isolation, seismic restraints, and casing attachment.
- C. Product Certificates: For factory-fabricated casings, signed by product manufacturer.
 - 1. Show airborne sound transmission losses lower than those scheduled when tested according to ASTM E 90.

1.05 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.02 SHEET METAL MATERIALS

- A. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653/A 653M and having G90 (Z275) coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.
- B. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet steel casings.
- C. Tie Rods: Galvanized steel, 1/4-inch (6-mm) minimum diameter for lengths 36 inches (900-mm) or less; 3/8-inch (10-mm) minimum diameter for lengths longer than 36 inches (900-mm).
- D. Miscellaneous Materials and Products: Types and sizes required to comply with HVAC casing system requirements, including proper connection of ducts and equipment.

2.03 SEALANT MATERIALS

- A. Joint and Seam Sealants, General: The term "sealant" is not limited to materials of adhesive or mastic nature but includes tapes and combinations of open-weave fabric strips and mastics.
- B. Water-Based Joint and Seam Sealant: Flexible, adhesive sealant, resistant to UV light when cured, UL 723 listed, and complying with NFPA requirements for Class 1 ducts.
- C. Solvent-Based Joint and Seam Sealant: One-part, nonsag, solvent-release-curing, polymerized butyl sealant formulated with a minimum of 75 percent solids.
- D. Flanged Joint Mastics: One-part, acid-curing, silicone, elastomeric joint sealant complying with ASTM C 920, Type S, Grade NS, Class 25, Use O.
- E. Flange Gaskets: Butyl rubber or EPDM polymer with polyisobutylene plasticizer.

2.04 FACTORY-FABRICATED CASINGS

- A. Description: Double-wall, insulated, pressurized equipment casing.
 - 1. Available Manufacturers:
 - a. McGill AirFlow Corporation.
 - b. Semco
 - c. Or Approved Equal

- B. Panel Fabrication: Solid, galvanized sheet steel exterior shell and solid, galvanized sheet steel interior shell; with 2- or 4-inch (50- of 100- mm) space between shells, as indicated.
 - 1. Fabricate with a minimum number of joints.
 - 2. Weld exterior and interior shells to perimeter; to interior, longitudinal, galvanized-steel channels; and to box-end internal closures. Paint welds.
 - 3. Exterior Shell Thickness: 0.040 inch (1.0 mm) minimum.
 - 4. Interior Shell Thickness: 0.034 inch (0.85 mm) minimum.
 - 5. Fabricate perimeter and interior, longitudinal channel members with galvanized-steel shapes.
 - 6. Fill each panel assembly with insulating material that is noncombustible, inert, mildew resistant, and vermin proof, and that complies with NFPA 90A.
 - 7. Fabricate panels with tongue-and-groove, continuous self-locking joints effective inside and outside each panel.

- C. Trim Items: Fabricate from a minimum of 0.052-inch (1.3-mm) galvanized sheet steel, furnished in standard lengths for field cutting.

- D. Access Doors: Fabricate personnel access doors at least 24 by 72 inches (600- x 1800-mm) and other access doors in sizes indicated.
 - 1. Fabricate doors of same thickness as panels, with a minimum 0.040-inch (1.0-mm) solid, interior and exterior, galvanized sheet steel shell.
 - 2. Install a minimum of two ball-bearing hinges and two wedge-lever-type latches, operable from inside and outside. Install doors to open against air pressure differential. Install neoprene gaskets around entire perimeters of door frames.
 - 3. Fabricate windows in doors consisting of double-glazed, wire-reinforced safety glass with an air space between panes and sealed with interior and exterior rubber seals.

- E. Structural Performance: Fabricate plenum to be self-supporting and capable of withstanding internal static pressures as scheduled, without any panel joint exceeding deflection of $L/200$ where "L" is the unsupported span length within completed casings.
 - 1. Acoustic Performance: Certified by an independent acoustical testing agency listing sound-absorption and transmission-loss characteristics of panel assemblies.
 - 2. Thermal Conductivity (k-Value): 0.26 at 75 deg F (0.037 at 24 deg C) mean temperature.

- F. Static-Pressure Classifications: Unless otherwise indicated, fabricate HVAC casings according to the following:
 - 1. Before Fans: 6-inch wg (1500 Pa) .

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine concrete bases for compliance with requirements for conditions affecting installation and performance of HVAC casings.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install casings according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible." Comply with recommended spacing of sheet metal screws and with requirements for casing sealing and trim positioning.
- B. Apply sealant to joints, connections, and mountings.
- C. Field-cut openings for pipe and conduit penetrations; insulate and seal according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."
- D. Support casings on floor system. Secure and seal to base.
- E. Support components rigidly with ties, braces, brackets, seismic restraints, and anchors of types that will maintain housing shape and prevent buckling.
- F. Align casings accurately at connections, with 1/8-inch (3-mm) misalignment tolerance and with smooth interior surfaces.
- G. Maintain duct seal class integrity throughout casings.

3.03 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections according to SMACNA's "HVAC Air Duct Leakage Test Manual" and prepare test reports:
 - 1. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If pressure classes are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure. Give seven days' advance notice for testing.
 - 2. Determine leakage from entire system or section of system by relating leakage to surface area of test section. Comply with requirements for leakage classification of ducts connected to casings.

3. Remake leaking joints and retest until leakage is equal to or less than maximum allowable.

END OF SECTION

SECTION 15820

DUCT ACCESSORIES

PART 1 GENERAL

1.01 SUMMARY

- A. This Section includes the following:
 - 1. Volume dampers.
 - 2. Motorized control dampers.
 - 3. Duct silencers.
 - 4. Turning vanes.
 - 5. Duct-mounting access doors.
 - 6. Flexible connectors.
 - 7. Flexible ducts.
 - 8. Duct accessory hardware.

- B. Related Sections include the following:
 - 1. Division 13 Section "Fire Alarm" for duct-mounting fire and smoke detectors.
 - 2. Section 15910 "Direct Digital Controls" for electric and pneumatic damper actuators.

1.02 SUBMITTALS

- A. Product Data: For the following:
 - 1. Volume dampers.
 - 2. Motorized control dampers.
 - 3. Duct silencers.
 - 4. Turning vanes.
 - 5. Duct-mounting access doors.
 - 6. Flexible connectors.
 - 7. Flexible ducts.

- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Special fittings.
 - 2. Manual-volume damper installations.
 - 3. Motorized-control damper installations.
 - 4. Wiring Diagrams: Power, signal, and control wiring.

1.03 QUALITY ASSURANCE

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.02 SHEET METAL MATERIALS

- A. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated.
- B. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653/A 653M and having G90 (Z275) coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.
- C. Stainless Steel: ASTM A 480/A 480M.
- D. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- E. Tie Rods: Galvanized steel, 1/4-inch (6-mm) minimum diameter for lengths 36 inches (900 mm) or less; 3/8-inch (10-mm) minimum diameter for lengths longer than 36 inches (900 mm). Option for galvanized steel, 1/2 inch conduit per SMACNA.

2.03 VOLUME DAMPERS

- A. Available Manufacturers:
 - 1. Air Balance, Inc.
 - 2. American Warming and Ventilating.
 - 3. Flexmaster U.S.A., Inc.
 - 4. McGill AirFlow Corporation.
 - 5. METALAIRE, Inc.
 - 6. Nailor Industries Inc.
 - 7. Penn Ventilation Company, Inc.
 - 8. Ruskin Company.
 - 9. Vent Products Company, Inc.
 - 10. or Approved Equal
- B. General Description: Factory fabricated, with required hardware and accessories. Stiffen damper blades for stability. Include locking device to hold single-blade dampers in a fixed position without vibration. Close duct penetrations for damper components to seal duct consistent with pressure class.

1. Pressure Classes of 3-Inch wg (750 Pa) or Higher: End bearings or other seals for ducts with axles full length of damper blades and bearings at both ends of operating shaft.
- C. Standard Volume Dampers: Multiple- or single-blade, parallel- or opposed-blade design as indicated, standard leakage rating, and suitable for horizontal or vertical applications.
1. Steel Frames: Hat-shaped, galvanized sheet steel channels, minimum of 0.064 inch (1.62 mm) thick, with mitered and welded corners; frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts.
 2. Roll-Formed Steel Blades: 0.064-inch- (1.62-mm-) thick, galvanized sheet steel.
 3. Blade Axles: Galvanized steel .
 4. Bearings: Molded synthetic, Stainless-steel sleeve.
 5. Tie Bars and Brackets: Galvanized steel.
- D. Low-Leakage Volume Dampers: Multiple- or single-blade, parallel- or opposed-blade design as indicated, low-leakage rating, with linkage outside airstream, and suitable for horizontal or vertical applications.
1. Steel Frames: Hat-shaped, galvanized sheet steel channels, minimum of 0.064 inch (1.62 mm) thick, with mitered and welded corners; frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts.
 2. Roll-Formed Steel Blades: 0.064-inch- (1.62-mm-) thick, galvanized sheet steel.
 3. Blade Axles: Galvanized steel .
 4. Bearings: Molded synthetic Stainless-steel sleeve thrust or ball.
 5. Blade Seals: Neoprene.
 6. Jamb Seals: Cambered stainless steel.
 7. Tie Bars and Brackets: Galvanized steel.
- E. Jackshaft: 1-inch- (25-mm-) diameter, galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
1. Length and Number of Mountings: Appropriate to connect linkage of each damper in multiple-damper assembly.
- F. Damper Hardware: Zinc-plated, die-cast core with dial and handle made of 3/32-inch- (2.4-mm-) thick zinc-plated steel, and a 3/4-inch (19-mm) hexagon locking nut. Include center hole to suit damper operating-rod size. Include elevated platform for insulated duct mounting.

2.04 MOTORIZED CONTROL DAMPERS

- A. Available Manufacturers:
1. Air Balance, Inc.
 2. American Warming and Ventilating.
 3. CESCO Products.

4. Duro Dyne Corp.
5. Greenheck.
6. McGill AirFlow Corporation.
7. METALAIRE, Inc.
8. Nailor Industries Inc.
9. Penn Ventilation Company, Inc.
10. Ruskin Company.
11. Vent Products Company, Inc.
12. or Approved Equal

- B. General Description: AMCA-rated opposed-blade design; minimum of 0.1084-inch- (2.8-mm-) thick, galvanized-steel frames with holes for duct mounting; minimum of 0.0635-inch- (1.61-mm-) thick, galvanized-steel damper blades with maximum blade width of 8 inches (203 mm).
1. Secure blades to 1/2-inch- (13-mm-) diameter, zinc-plated axles using zinc-plated hardware, with nylon blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.
 2. Operating Temperature Range: From minus 40 to plus 200 deg F (minus 40 to plus 93 deg C).
 3. Provide opposed-blade design with inflatable seal blade edging, or replaceable rubber seals, rated for leakage at less than 10 cfm per sq. ft. (51 L/s per sq. m) of damper area, at differential pressure of 4-inch wg (995 Pa) when damper is being held by torque of 50 in. x lbf (5.6 N x m); when tested according to AMCA 500D.

2.05 DUCT SILENCERS

- A. Available Manufacturers:
1. Industrial Noise Control, Inc.
 2. McGill AirFlow Corporation.
 3. Ruskin Company.
 4. Vibro-Acoustics.
 5. Dynasonics
 6. Rink
 7. or Approved Equal
- B. General Description: Factory-fabricated and -tested, round or rectangular silencers with performance characteristics and physical requirements as indicated.
- C. Fire Performance: Adhesives, sealants, packing materials, and accessory materials shall have fire ratings not exceeding 25 for flame-spread index and 50 for smoke-developed index when tested according to ASTM E 84.
- D. Rectangular and Elbow Units: Fabricate casings with a minimum of 0.034-inch- (0.85-mm-) thick, solid galvanized sheet metal for outer casing and 0.022-inch- (0.55-mm-) thick, ASTM A 653/A 653M, G90 (Z275), perforated galvanized sheet metal for inner casing.

- E. Sheet Metal Perforations: 1/8-inch (3-mm) diameter for inner casing and baffle sheet metal.
- F. Fill Material: Inert and vermin-proof fibrous material, packed under not less than 5 percent compression.
 - 1. Erosion Barrier: Mylar bag enclosing fill and heat-sealed before assembly.
- G. Fabricate silencers to form rigid units that will not pulsate, vibrate, rattle, or otherwise react to system pressure variations.
 - 1. Do not use nuts, bolts, or sheet metal screws for unit assemblies.
 - 2. Lock form and seal or continuously weld joints.
 - 3. Suspended Units: Factory-installed suspension hooks or lugs attached to frame in quantities and spaced to prevent deflection or distortion.
 - 4. Reinforcement: Cross or trapeze angles for rigid suspension.
- H. Source Quality Control:
 - 1. Acoustic Performance: Test according to ASTM E 477.
 - 2. Record acoustic ratings, including dynamic insertion loss and self-noise power levels with an airflow of at least 2000-fpm (10-m/s) face velocity.
 - 3. Leak Test: Test units for airtightness at 200 percent of associated fan static pressure or 6-inch wg (1500-Pa) static pressure, whichever is greater.

2.06 TURNING VANES

- A. Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for vanes and vane runners. Vane runners shall automatically align vanes.
- B. Manufactured Turning Vanes: Fabricate 1-1/2-inch- (38-mm-) wide, double-vane, curved blades of galvanized sheet steel set 3/4 inch (19 mm) o.c.; support with bars perpendicular to blades set 2 inches (50 mm) o.c.; and set into vane runners suitable for duct mounting.
 - 1. Available Manufacturers:
 - a. Ductmate Industries, Inc.
 - b. Duro Dyne Corp.
 - c. METALAIRE, Inc.
 - d. Ward Industries, Inc.
 - e. or Approved Equal

2.07 DUCT-MOUNTING ACCESS DOORS

- A. General Description: Fabricate doors airtight and suitable for duct pressure class.
- B. Door: Double wall, duct mounting, and rectangular; fabricated of galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class. Include vision panel where indicated. Include 1-by-1-inch (25-by-25-mm) butt or piano hinge and cam latches.
 - 1. Available Manufacturers:

- a. American Warming and Ventilating.
 - b. CESCO Products.
 - c. Ductmate Industries, Inc.
 - d. Flexmaster U.S.A., Inc.
 - e. Greenheck.
 - f. McGill AirFlow Corporation.
 - g. Nailor Industries Inc.
 - h. Ventfabrics, Inc.
 - i. Ward Industries, Inc.
 - j. or Approved Equal
- 2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
 - 3. Provide number of hinges and locks as follows:
 - a. Less Than 12 Inches (300 mm) Square: Secure with two sash locks.
 - b. Up to 18 Inches (450 mm) Square: Two hinges and two sash locks.
 - c. Up to 24 by 48 Inches (600 by 1200 mm): Three hinges and two compression latches.
 - d. Sizes 24 by 48 Inches (600 by 1200 mm) and Larger: One additional hinge.
- C. Door: Double wall, duct mounting, and round; fabricated of galvanized sheet metal with insulation fill and 1-inch (25-mm) thickness. Include cam latches.
- 1. Available Manufacturers:
 - a. Flexmaster U.S.A., Inc.
 - b. or Approved Equal
 - 2. Frame: Galvanized sheet steel, with spin-in notched frame.

2.08 FLEXIBLE CONNECTORS

- A. Available Manufacturers:
- 1. Duro Dyne Corp.
 - 2. Ventfabrics, Inc.
 - 3. Ward Industries, Inc.
 - 4. or Approved Equal
- B. General Description: Flame-retardant or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1.
- C. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches (89 mm) wide attached to two strips of 2-3/4-inch- (70-mm-) wide, 0.028-inch- (0.7-mm-) thick, galvanized sheet steel. Select metal compatible with ducts.
- D. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
- 1. Minimum Weight: 26 oz./sq. yd. (880 g/sq. m).
 - 2. Tensile Strength: 480 lbf/inch (84 N/mm) in the warp and 360 lbf/inch (63 N/mm) in the filling.
 - 3. Service Temperature: Minus 40 to plus 200 deg F (Minus 40 to plus 93 deg C).

- E. High-Corrosive-Environment System, Flexible Connectors: Glass fabric with chemical-resistant coating.
 - 1. Minimum Weight: 14 oz./sq. yd. (474 g/sq. m).
 - 2. Tensile Strength: 450 lbf/inch (79 N/mm) in the warp and 340 lbf/inch (60 N/mm) in the filling.
 - 3. Service Temperature: Minus 67 to plus 500 deg F (Minus 55 to plus 260 deg C).

2.09 FLEXIBLE DUCTS

- A. Available Manufacturers:
 - 1. Ductmate Industries, Inc.
 - 2. Flexmaster U.S.A., Inc.
 - 3. Hart & Cooley, Inc.
 - 4. McGill AirFlow Corporation.
 - 5. or Approved Equal
- B. Insulated-Duct Connectors: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene vapor barrier film.
 - 1. Pressure Rating: 10-inch wg (2500 Pa) positive and 1.0-inch wg (250 Pa) negative.
 - 2. Maximum Air Velocity: 4000 fpm (20.3 m/s).
 - 3. Temperature Range: Minus 10 to plus 160 deg F (Minus 23 to plus 71 deg C).
- C. Flexible Duct Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action, in sizes 3 through 18 inches (75 to 450 mm) to suit duct size.

2.10 DUCT ACCESSORY HARDWARE

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct insulation thickness.
- B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 EXECUTION

3.01 APPLICATION AND INSTALLATION

- A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for metal ducts.
- B. Provide duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel, stainless-steel accessories in stainless-steel.

- C. Provide balancing dampers at points on supply, return, and exhaust systems where branches lead from larger ducts as required for air balancing. Install at a minimum of two duct widths from branch takeoff.
- D. Provide test holes at fan inlets and outlets and elsewhere as indicated.
- E. Install duct silencers rigidly to ducts.
- F. Install duct access doors to allow for inspecting, adjusting, and maintaining accessories and terminal units as follows:
 - 1. On both sides of duct coils.
 - 2. Downstream from volume dampers, turning vanes, and equipment.
 - 3. To interior of ducts for cleaning; before and after each change in direction, at maximum 50-foot (15-m) spacing.
 - 4. On sides of ducts where adequate clearance is available.
- G. Install the following sizes for duct-mounting, rectangular access doors:
 - 1. One-Hand or Inspection Access: 8 by 5 inches (200 by 125 mm).
 - 2. Two-Hand Access: 12 by 6 inches (300 by 150 mm).
 - 3. Head and Hand Access: 18 by 10 inches (460 by 250 mm).
 - 4. Head and Shoulders Access: 21 by 14 inches (530 by 355 mm).
 - 5. Body Access: 25 by 14 inches (635 by 355 mm).
 - 6. Body Plus Ladder Access: 25 by 17 inches (635 by 430 mm).
- H. Install the following sizes for duct-mounting, round access doors:
 - 1. One-Hand or Inspection Access: 8 inches (200 mm) in diameter.
 - 2. Two-Hand Access: 10 inches (250 mm) in diameter.
 - 3. Head and Hand Access: 12 inches (300 mm) in diameter.
 - 4. Head and Shoulders Access: 18 inches (460 mm) in diameter.
 - 5. Body Access: 24 inches (600 mm) in diameter.
- I. Label access doors according to Section 15075 "Identification."
- J. Install flexible connectors immediately adjacent to equipment in ducts associated with fans and motorized equipment supported by vibration isolators.
- K. For fans developing static pressures of 5-inch wg (1250 Pa) and higher, cover flexible connectors with loaded vinyl sheet held in place with metal straps.
- L. Connect diffusers to low pressure ducts directly or with maximum 48-inch (1219-mm) lengths of flexible duct clamped or strapped in place, where permitted on drawings.
- M. Connect flexible ducts to metal ducts with draw bands.
- N. Install duct test holes where indicated and required for testing and balancing purposes.

3.02 ADJUSTING

- A. Adjust duct accessories for proper settings.
- B. Final positioning of manual-volume dampers is specified in Section 15950 "Testing, Adjusting, and Balancing."

END OF SECTION

SECTION 15838

POWER VENTILATORS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section includes the following:
 - 1. Utility set fans-Process Exhaust.

1.02 PERFORMANCE REQUIREMENTS

- A. Project Altitude: Base air ratings on sea-level conditions.
- B. Operating Limits: Classify according to AMCA 99.

1.03 SUBMITTALS

- A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:
 - 1. Certified fan performance curves with system operating conditions indicated.
 - 2. Certified fan sound-power ratings.
 - 3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
 - 4. Material gages and finishes, including color charts.
 - 5. Dampers, including housings, linkages, and operators.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.
 - 2. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.

1.04 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.
- C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

D. UL Standard: Power ventilators shall comply with UL 705.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver fans as factory-assembled unit, to the extent allowable by shipping limitations, with protective crating and covering.
- B. Disassemble and reassemble units, as required for moving to final location, according to manufacturer's written instructions.
- C. Lift and support units with manufacturer's designated lifting or supporting points.

1.06 COORDINATION

- A. Coordinate size and location of structural-steel support members.
- B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3 Section "Cast-in-Place Concrete."
- C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7 Section "Roof Accessories."

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Utility Set Fans:
 - a. Aerovent; a Twin City Fan Company.
 - b. Carnes Company HVAC.
 - c. Cook, Loren Company.
 - d. Hartzell Fan, Inc.
 - e. Industrial Air Division, Lau Commercial Industrial Fans/Lau Industries.
 - f. JennFan; Div. of Breidert Air Products, Inc.
 - g. Madison Manufacturing/Peerless-Winsmith, Inc.
 - h. New York Blower Company (The).
 - i. Penn Ventilation Companies, Inc.
 - j. Trane Co. (The).
 - k. Greenheck
 - l. or Approved Equal

2.02 UTILITY SET FANS-STEEL

- A. Description: Belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, and accessories. Variable fre-

quency drive shall be furnished by fan manufacturer to meet requirements of Section 16425 "Low Voltage Variable Frequency Drives (VFD) Stand-Alone Type".

- B. Housing: Fabricated of heavy gauge steel with continuously welded construction.
 - 1. Housing Discharge Arrangement: Adjustable to eight standard positions.
- C. Fan Wheels: Single-width, single inlet; and spun-steel inlet cone, with hub keyed to shaft.
 - 1. Blade Materials: Aluminum.
 - 2. Blade Type: Airfoil or Radial as noted on schedule.
 - 3. Spark-Resistant Construction: AMCA 99.
- D. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
- E. Shaft Bearings: Prelubricated and sealed, self-aligning, pillow-block-type ball bearings with ABMA 9, L₅₀ of 200,000 hours.
- F. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.
 - 1. Service Factor Based on Fan Motor: 1.2.
 - 2. Motor Pulleys: Fixed pitch.
 - 3. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
 - 4. Belt Guards: Fabricate of steel for motors mounted on outside of fan cabinet.
- G. Accessories:
 - 1. Access Doors: Gasketed doors with latch-type handles.
 - 2. Drain Connections: NPS 3/4 (DN 20) threaded coupling drain connection installed at lowest point of housing.
 - 3. Weather Hoods: Weather resistant with stamped vents over motor and drive compartment.

2.03 UTILITY SET FANS-FRP

- A. Description: Belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, and accessories.
- B. Housing: Fabricated of FRP with all nuts, bolts and fasteners in 316 SS and encapsulated in FRP.
 - 1. Housing Discharge Arrangement: Adjustable to eight standard positions.
- C. Fan Wheels: Single-width, single inlet; welded to cast-iron or cast-steel hub and spun-steel inlet cone, with hub keyed to shaft.
 - 1. Blade Materials: FRP.
 - 2. Blade Type: Backward inclined.
 - 3. Spark-Resistant Construction: AMCA 99.
- D. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.

- E. Shaft Bearings: Prelubricated and sealed, self-aligning, pillow-block-type ball bearings with ABMA 9, L₅₀ of 200,000 hours.
- F. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.
 - 1. Service Factor Based on Fan Motor: 1.2.
 - 2. Motor Pulleys: Fixed pitch.
 - 3. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
 - 4. Belt Guards: Fabricate of steel for motors mounted on outside of fan cabinet.
- G. Accessories:
 - 1. Access Doors: Gasketed doors with latch-type handles.
 - 2. Inlet Screens: Removable wire mesh.
 - 3. Drain Connections: NPS 3/4 (DN 20) threaded coupling drain connection installed at lowest point of housing.
 - 4. Weather Hoods: Weather resistant with stamped vents over motor and drive compartment.

2.04 MOTORS

- A. Motor Construction: NEMA MG 1, general purpose, continuous duty, Design B.
- B. Enclosure Type: Open dripproof.

2.05 SOURCE QUALITY CONTROL

- A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.
- B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install power ventilators level and plumb.
- B. Support units using spring isolators having a static deflection of 1.5 inch (37.5 mm). Vibration- and seismic-control devices are specified in Section 15065 "Vibration Isolation."
 - 1. Secure vibration and seismic controls to concrete bases using anchor bolts cast in concrete base.

- C. Install floor-mounting units on concrete bases. Concrete, reinforcement, and formwork requirements are specified in Section 03300 "Cast-in-Place Concrete."
- D. Secure roof-mounting fans to roof curbs with cadmium-plated hardware. Refer to Division 7 Section "Roof Accessories" for installation of roof curbs.
- E. Install units with clearances for service and maintenance.
- F. Label units according to requirements specified in Section 15075 "Identification."

3.02 CONNECTIONS

- A. Duct installation and connection requirements are specified in other Section 15815 "Metal Ducts" and Section 15816 "Nonmetal Ducts." Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 15820 "Duct Accessories."
- B. Install ducts adjacent to power ventilators to allow service and maintenance.
- C. Ground equipment.
- D. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.03 FIELD QUALITY CONTROL

- A. Equipment Startup Checks:
 - 1. Verify that shipping, blocking, and bracing are removed.
 - 2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
 - 3. Verify that cleaning and adjusting are complete.
 - 4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
 - 5. Verify lubrication for bearings and other moving parts.
 - 6. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
 - 7. Disable automatic temperature-control operators.
- B. Starting Procedures:
 - 1. Energize motor and adjust fan to indicated rpm.
 - 2. Measure and record motor voltage and amperage.
- C. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, replace with new units, and retest.

- D. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- E. Shut unit down and reconnect automatic temperature-control operators.
- F. Refer to Section 15950 "Testing, Adjusting, and Balancing" for testing, adjusting, and balancing procedures.
- G. Replace fan and motor pulleys as required to achieve design airflow.
- H. Repair or replace malfunctioning units. Retest as specified above after repairs or replacements are made.

3.04 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Adjust belt tension.
- C. Lubricate bearings.

3.05 CLEANING

- A. On completion of installation, internally clean fans according to manufacturer's written instructions. Remove foreign material and construction debris. Vacuum fan wheel and cabinet.
- B. After completing system installation, including outlet fitting and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes.

3.06 DEMONSTRATION

- A. Engage a factory-authorized service representative to train maintenance personnel to adjust, operate, and maintain power ventilators.
 - 1. Train maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.

END OF SECTION

SECTION 15840

AIR TERMINAL UNITS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes the following:
 - 1. Shutoff single-duct air terminal units.

1.03 SUBMITTALS

- A. Product Data: For each type of product indicated, include rated capacities, furnished specialties, sound-power ratings, and accessories.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Include a schedule showing unique model designation, room location, model number, size, and accessories furnished.
 - 2. Wiring Diagrams: Power, signal, and control wiring.
- C. Operation and Maintenance Data: For air terminal units to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "," include the following:
 - 1. Instructions for resetting minimum and maximum air volumes.
 - 2. Instructions for adjusting software set points.

1.04 QUALITY ASSURANCE

- A. Product Options: Drawings indicate size, profiles, and dimensional requirements of air terminal units and are based on the specific system indicated.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. NFPA Compliance: Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."

1.05 COORDINATION

- A. Coordinate layout and installation of air terminal units and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.02 SHUTOFF SINGLE-DUCT AIR TERMINAL UNITS

- A. Manufacturers:
 - 1. Anemostat; a Mestek Company.
 - 2. Carnes.
 - 3. Environmental Technologies, Inc.; Enviro-Air Div.
 - 4. Krueger.
 - 5. METALAIRE, Inc.; Metal Industries Inc.
 - 6. Nailor Industries of Texas, Inc.
 - 7. Price Industries.
 - 8. Titus.
 - 9. Trane Company (The); Worldwide Applied Systems Group.
 - 10. Tuttle & Bailey.
 - 11. Or Approved Equal
- B. Configuration: Volume-damper assembly inside unit casing with control components located inside a protective metal shroud.
- C. Casing: 0.034-inch (0.85-mm) steel.
 - 1. Casing Lining: 3/4-inch- (19-mm-) thick, non-porous sealed duct liner complying with UL 181 and NFPA 255; secured with adhesive.
 - 2. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
 - 3. Air Outlet: S-slip and drive connections.
 - 4. Access: Removable panels for access to dampers and other parts requiring service, adjustment, or maintenance; with airtight gasket.
- D. Regulator Assembly: Extruded-aluminum or galvanized-steel components; key damper blades onto shaft with nylon-fitted pivot points located inside unit casing.
 - 1. Automatic Flow-Control Assembly: Combined spring rates shall be matched for each volume-regulator size with machined dashpot for stable operation.

2. Factory-calibrated and field-adjustable assembly with shaft extension for connection to externally mounted control actuator.
- E. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.
1. Maximum Damper Leakage: ARI 880 rated, 2 percent of nominal airflow at 3-inch wg (750-Pa) inlet static pressure.
 2. Damper Position: Normally open.
- F. Hot-Water Heating Coil: Copper tube, mechanically expanded into aluminum-plate fins; leak tested underwater to 200 psig (1380 kPa); and factory installed.
- G. DDC Controls: Bidirectional damper operators and microprocessor-based controller shall be compatible with temperature controls specified in Division 15 Section "Direct Digital Controls" and shall have the following features:
1. Damper Actuator: 24 V, powered closed, spring return open.
 2. Terminal Unit Controller: Pressure-independent, variable-air-volume controller with electronic airflow transducer with multipoint velocity sensor at air inlet, factory calibrated to minimum and maximum air volumes, and having the following features:
 - a. Proportional, plus integral control of room temperature.
 - b. Time-proportional reheat-coil control.
 - c. Adjusting and monitoring with portable terminal.
 - d. Communication with temperature-control system specified in Division 15 Section "Direct Digital Controls".
- H. Control Sequence:
1. Suitable for operation with duct pressures between 0.25- and 3.0-inch wg (60- and 750-Pa) inlet static pressure.

2.03 SOURCE QUALITY CONTROL

- A. Identification: Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, coil type, and ARI certification seal.
- B. Verification of Performance: Rate air terminal units according to ARI 880.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.

3.02 CONNECTIONS

- A. Piping installation requirements are specified in other Sections 15180 "Hydronic Heating and Cooling Piping Systems." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to air terminal units to allow service and maintenance.
- C. Hot-Water Piping: In addition to requirements in Division 15 Section "Hydronic Piping," connect heating coils to supply with shutoff valve, strainer, control valve, and union or flange; and to return with balancing valve and union or flange.
- D. Connect ducts to air terminal units according to Division 15 Section "Metal Ducts."

3.03 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.
 - 2. Leak Test: After installation, fill water coils and test for leaks. Repair leaks and retest until no leaks exist.
 - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Remove and replace malfunctioning units and retest as specified above.

3.04 STARTUP SERVICE

- A. Perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions and do the following:
 - a. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.
 - b. Verify that controls and control enclosure are accessible.
 - c. Verify that control connections are complete.
 - d. Verify that nameplate and identification tag are visible.
 - e. Verify that controls respond to inputs as specified.

END OF SECTION

SECTION 15855

DIFFUSERS, REGISTERS, AND GRILLES

PART 1 GENERAL

1.01 SUMMARY

- A. This Section includes ceiling- and wall-mounted diffusers, registers, and grilles.
- B. Related Sections include the following:
 - 1. Section 15820 "Duct Accessories" for volume-control dampers not integral to diffusers, registers, and grilles.

1.02 SUBMITTALS

- A. Product Data: For each product indicated, include the following:
 - 1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
 - 2. Diffuser, Register, and Grille Schedule: Indicate Drawing designation, room location, quantity, model number, size, and accessories furnished.
- B. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
 - 1. Ceiling suspension assembly members.
 - 2. Method of attaching hangers to building structure.
 - 3. Size and location of initial access modules for acoustical tile.
 - 4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
 - 5. Duct access panels.
- C. Samples for Initial Selection: For diffusers, registers, and grilles with factory-applied color finishes.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Products: Subject to compliance with requirements, provide one of the products specified.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.02 GRILLES AND REGISTERS

A. Return Grille

1. Basis of Design:
 - a. Nailor Industries of Texas Inc.; Model # 5145H.
2. Available Manufacturers:
 - a. Anemostat; a Mestek Company.
 - b. Carnes.
 - c. Dayus Register & Grille.
 - d. Hart & Cooley, Inc.; Hart & Cooley Div.
 - e. Krueger.
 - f. METALAIRE, Inc.; Metal Industries Inc.
 - g. Nailor Industries of Texas Inc.
 - h. Price Industries.
 - i. Titus.
 - j. Tuttle & Bailey.
 - k. or Approved Equal
3. Material: Aluminum.
4. Finish: Baked enamel, white.
5. Face Blade Arrangement: Fixed horizontal spaced 3/4 inch (19 mm) apart.
6. Rear Blade Arrangement: Fixed vertical reinforcing support.
7. Frame: 1-1/4 inches (32 mm) wide.
8. Mounting: Countersunk screw.

2.03 SOURCE QUALITY CONTROL

- A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install diffusers, registers, and grilles level and plumb.
- B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practicable. For units in-

stalled in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify COR for a determination of final location.

- C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.03 ADJUSTING

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION

SECTION 15860

AIR CLEANING DEVICES

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: The work specified in this Section consists of providing the specialties for filtering systems.
- B. Related Sections:
 - 1. Modular Air-Handling Units: Section 15725

1.02 REFERENCES

- A. Air-Conditioning and Refrigeration Institute (ARI)
 - 1. ARI 680: Air Filter Equipment.
 - 2. ARI 850: Commercial and Industrial Air Filter Equipment.
- B. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE):
 - 1. ASHRAE 52: Methods of Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.
- C. National Fire Protection Association, Inc. (NFPA):
 - 1. NFPA 90A: Installation of Air Conditioning and Ventilating Systems.
 - 2. NFPA 90B: Installation of Warm Air Heating and Air Conditioning Systems.
 - 3. NFPA 255: Surface Burning Characteristics of Building Materials.
- D. Underwriters Laboratories, Inc. (UL):
 - 1. UL900: Test Performance of Air Filter Units.

1.03 SUBMITTALS

- A. Product Data: Submittals required for the following items:
 - 1. Submit product data for each manufactured component.

PART 2 PRODUCTS

2.01 PLEATED FILTERS

- A. Filter Characteristics:
 - 1. Medium efficiency filters that are pleated and disposable.
 - 2. Each filter consists of filter media, media support grid and enclosing frame.

3. Thickness: As indicated.

4. UL listed Class 1.

B. Filter Media:

1. Non-woven cotton fabric type.

2. Minimum effective filter media per 1.0 square foot of face area: As indicated.

3. Minimum pleats per linear foot of filter face area: As indicated.

4. Average efficiency: As indicated.

5. Average arrestance: As indicated.

C. Media Support Grid:

1. Welded wire construction.

2. Minimum effective open area: 96 percent.

3. Weld grid on 1 inch centers and posttreated for corrosion resistance.

4. Add a rust inhibiting adhesive for proper bonding of the media to the grid, eliminating oscillation of the media.

D. Enclosing Frame:

1. Rigid, heavy duty, high wet- strength beverage board.

2. Bond diagonal supports to the entering and exiting air sides of the each pleat.

E. Pleated Filter Schedule:

<u>Efficiency</u>	<u>Thickness</u>	<u>Average Efficiency</u>	<u>Sq ft of Media per 1.0 sq ft of Face Area</u>	<u>Average Arrestance</u>	<u>Pleats per Lineal Foot of Filter Area</u>	<u>Final Dust Holding Capacity</u>	<u>Farr Model No.</u>
25%	2"	25%-30%	4.6	90%-93%	15	200 grams	30/30

F. Acceptable Manufacturers:

1. Farr.

2. Flanders

3. American Air Filter

4. Or Approved Equal

2.02 CARTRIDGE FILTERS

A. Filter Characteristics:

1. High performance, deep pleated, totally rigid and disposable.

2. Each filter consists of filter media, media support grid, contour stabilizers, and enclosing frame.
3. Thickness: As indicated.
4. UL listed Class 1.

B. Filter Media:

1. Type: High density microfine glass fiber laminated into a non-woven backing forming a lofted filter blanket.
2. Average efficiency: As indicated.
3. Average arrestance: As indicated.
4. Final dust holding capacity: As indicated.

C. Media Support Grid:

1. Welded wire construction.
2. Minimum effective open area: 96 percent.
3. Weld on 1 inch centers and post treat for corrosion resistance.
4. Add rust inhibiting adhesive for proper bonding of the media to grid, eliminating oscillation of the media.

D. Contour Stabilizers:

1. Permanently installed all metal construction on both sides of the filter media pack.
2. Four stabilizers on the entering side and six on the exiting side ensuring a tapered pleat.
3. Capable of withstanding 10 inch W.G. resistance without noticeable distortion.

E. Enclosing Frame:

1. Minimum 26 gauge galvanized steel.
2. Arrange metal diagonal support members in a diamond configuration on both sides of the assembly.
3. Bond the periphery of the enclosing frame to the filter pack eliminating the possibility of air bypass.
4. Provide a mechanical seal on each side of the assembly.

F. Cartridge Filter Schedule:

<u>Efficiency</u>	<u>Thickness</u>	<u>Average Efficiency</u>	<u>Average Arrestance</u>	<u>Final Dust Holding Capacity</u>	<u>Farr Model No.</u>
95%	12"	90%-95%	99%	190 grams	Riga-Flo 200

G. Acceptable Manufacturers and Products:

1. Farr.
2. Flanders
3. American Air Filter.
4. Or Approved Equal

2.03 FILTER HOUSINGS

A. Side Access, Multi-stage Filter Housing:

1. Furnished by air handling unit manufacturer.

2.04 FILTER GAUGES

A. Components:

1. Two (2) static pressure taps with integral compression fittings.
2. Two (2) five foot lengths of 1/4 inch aluminum tubing.
3. Molded plastic vent valve.

B. Magnehelic Filter Gauge:

1. Scale: 3-7/8 inch diameter aluminum 0 inch - 2.0 inch W.G. range.
2. Accuracy: Plus or minus 2 percent of full scale.
3. Two 1/8 inch SPT plugs for duplicate pressure taps.
4. Adapters and mounting hardware.
5. Acceptable manufacturers and products: Dwyer 2002-AF or equal.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's recommendations.

B. Filter Gauge Characteristics:

1. Provide filter gauge to indicate the pressure drop across each filter section.
Coordinate installation with air handling unit manufacturer.

3.02 PROVISIONS

A. Provide two sets of media for all filters:

1. Use first set for heating and ventilation during construction of the building.
2. Replace these filters with the second set just prior to Government occupancy.

END OF SECTION

SECTION 15910

ENERGY MANAGEMENT AND CONTROL SYSTEM

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: All labor, materials and devices required for the furnishing, installing and testing of a computer based Energy Management and Automatic Temperature Control System, complete and ready for operation in a manner satisfactory to the ROICC. Include all work as indicated on the Drawings, as specified herein and in accordance with the point list.
 - 1. Controls shall be DDC with electric actuators.
- B. The Energy Management and Automatic Temperature Control System is referred to as the "EMCS" for future reference in this specification.

1.02 REQUIREMENTS OF REGULATORY AGENCIES AND STANDARDS

- A. Regulatory Agencies:
 - 1. International Basic Building Code, 1996 Edition.
 - 2. International Mechanical Code, 1996 Edition.
 - 3. International Plumbing Code, 1996 Edition.
 - 4. The BOCA National Energy Conservation Code, 1993 Edition.
- B. Reference Standards:
 - 1. American Society for Testing and Materials (ASTM).
 - 2. Underwriters' Laboratories, Inc. (UL).
 - 3. National Fire Protection Association (NFPA).
 - 4. American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE).
 - 5. National Electrical Code (NEC).
 - 6. National Electrical Manufacturers Association (NEMA).

1.03 QUALITY ASSURANCE

- A. Acceptable Manufacturers: All products, material, and equipment shall be manufactured by Siemens Building Technologies. The EMCS system shall be designed and installed, commissioned and serviced by Siemens Building Technologies

employed, factory trained personnel. Distributors or licensed installing contractors are not acceptable.

B. Scope of Work

1. This specification defines the minimum local hardware and performance requirements for a computer-based Energy Management and Automatic Temperature Control System.
2. The EMCS is to tie into the existing central Siemens Control System located in Building 57 to facilitate remote control, monitoring, and alarm capabilities.
3. As the EMCS Contractor, furnish and install all equipment, accessories, wiring and instrument piping required for a complete and functioning Energy Management System and Automatic Temperature Control System.
4. All materials and equipment used are to be standard components, regularly manufactured for this and/or other systems and not custom designed especially for this project. All systems and components are to be thoroughly tested and proven in actual use. All material and equipment are to be installed by the manufacturer. Installing representatives will not be acceptable.

1.04 SUBMITTALS

A. Manufacturer's literature and illustrations.

B. Manufacturer's specifications and engineering data.

1. Materials.
2. Parts.
3. Devices.
4. Accessories.
5. Performance Data.

C. Shop Drawings.

1. Assembly.
2. Installation.
3. Wiring Diagram.
4. Provide electronic format for control documentation (drawings, sequence of operation, and parts list).

D. At the completion of work, submit report of check-out of the automatic control system.

E. Operation and Maintenance Manual:

1. The manual shall include the following data.

- a. Installation instructions.
 - 1) Assembly.
 - 2) Installation.
 - 3) Alignment.
 - 4) Adjustment.
 - 5) Checking.
- b. Operation instructions:
 - 1) Start-up.
 - 2) Routine and normal instructions.
 - 3) Regulation and Control.
 - 4) Shut-down.
- c. Maintenance instructions.
- d. Guide to Trouble Shooting.
- e. Parts List.

1.05 WARRANTY

- A. Provide a one (1) year warranty from date of final acceptance by the ROICC or Certification of substantial completion, whichever occurs later, for items furnished that shall cover.
 - 1. Faulty or inadequate product design.
 - 2. Improper assembly or erection.
 - 3. Defective workmanship and materials.
 - 4. Leakage, breakage or other failures.

PART 2 PRODUCTS

2.01 GENERAL

- A. The EMCS shall incorporate the following:
 - 1. A network of independent, Modular Building direct digital control units and Mechanical equipment controllers controllers.
 - 2. A network of independent terminal box Direct Digital Control units.
 - 3. A trunk interface for communication to the master console or remote consoles.
 - 4. Field sensors per the input/output summary and as necessary to accomplish the sequence of operation.
 - 5. Ethernet interface for communications to existing remote workstation at Building 57 utilizing Siemens Building Technologies *Apogee* NT software. The operation must be able to access, command, and edit all point and program information in the new network from any existing remote workstation.

B. Distributed Processing:

1. Each Modular Building Control unit (MBC) shall be capable of performing all specified control functions in a complete independent manner.
2. "Independent" shall be defined as:
 - a. If any one control unit or communications processor malfunctions within the system, all other control units will continue to control, monitor, have the ability to be accessed and programmed without being in a degraded mode.

C. Networking:

1. Each Modular Building Control unit shall be capable of sharing point information with other such units, such that control sequences or control loops executed at one control unit may receive input signals from sensors connected to other units within the network without the intervention of the host computer or any hardware other than the modular building controller.
2. If the network communication link fails or the originating control unit malfunctions, the control loop shall continue to function using the last value received from the failed modular building controller or programmed to take special procedures.
3. Each modular building controller shall have an RS-232 port for use by an ASCII text terminal.
4. This port shall be capable of communicating with the entire network without moving the operators terminal to other MBC's or providing any other hardware or software.
5. Failure of the host shall not affect network and panel to panel communication.
6. Failure of one modular building controller shall have no other effect upon any of the units in the network.

2.02 SENSORS

A. Provide the following instrumentation as required by the monitoring, control and optimization functions.

1. Temperature sensors.
 - a. Room temperature:

Temperature monitoring range	+20/+120 F (0/49 C)
Output signal	Changing resistance
Accuracy at Calibration point	+/- 1.0F (+/- 0.55 C)
Ultra Quiet Measurement Area Accuracy (Space sensors for ultra quiet rooms are ceiling hung via flexible connectors)	+/- 0.2F (+/- 0.1 C)
 - b. Liquid immersion temperature:

- | | | |
|----|---|--|
| | Temperature monitoring range | +22/+220 F (0/104C) |
| | Output signal | Changing resistance |
| | Accuracy at Calibration point | +/-0.5 F (+/- 0.3 C) |
| c. | Duct (single point) temperature: | |
| | Temperature monitoring range | +40/+150 F (4.4/66 C) |
| | Output signal | Changing resistance |
| | Accuracy at Calibration point | +/-0.5 F (+/- 0.3 C) |
| d. | Duct (average) temperature: | |
| | Temperature monitoring range | +20/+120 F (-7/+49 C) |
| | Output signal | 4 - 20 mA DC |
| | Accuracy at Calibration point | +/-1 F (+/- 0.6 C) |
| | Sensor Probe Length | 25' L (7.3 m) |
| e. | Outside air temperature: | |
| | Temperature monitoring range | -58/+122 F |
| | Output signal | 4 - 20 mA DC |
| | Accuracy at Calibration point | +/-0.5 F (+/- 0.3 c) |
| | | |
| 2. | Liquid Differential Pressure Transmitter | |
| | Ranges | 0-5/30 inches H2O
0-25/150 inches H2O
0-125/750 inches H2O |
| | Output | 4 - 20 Ma DC |
| | Calibration Adjustments | Zero and span |
| | Accuracy | +/-0.2% of span |
| | Linearity | +/-0.1% of span |
| | Hysteresis | +/-0.05% of span |
| | | |
| 3. | Differential pressure: | |
| a. | Unit for fluid flow proof shall be Penn P74. | |
| | Range | 8 to 70 psi |
| | Differential | 3 psi |
| | Maximum differential pressure | 200 psi |
| | Maximum pressure | 325 psi |
| b. | Unit for air flow shall be Siemens Building Technologies SW141. | |
| | Set point ranges | .05" WG to 1.0" WG
1.0" WG to 12.0" WG |
| | | |
| 4. | Static Pressure: | |

a. Static pressure sensor:	
Range	0 to .5" WG • to 1" WG • to 2" WG • to 5" WG • to 10" WG
Output Signal	4 - 20 mA VDC
Combined static error	0.5% full range
Operating Temperature	-40 to 175 F.

5. Humidity Sensors

Ranges	0 to 99% RH
Sensing Element	Bulk Polymer
Output Signal	4 - 20 mA DC
Accuracy	At 77°F ± 5% RH

6. Insertion Flow Meters (Equal to Onicon Series F-1200)

Sensing Method	Impedance Sensing
Accuracy	± 2% of Actual Reading
Maximum Operating Pressure	400 PSI
Output Signal	4 - 20 mA
Bi-directional where required.	

2.03 CONTROL VALVES (All control valves shall have electric actuators).

A. Electric Control

Rangeability	40:1
Flow Characteristics	Modify. equal percentage
Control Action	Normal open or Closed as Selected.
Medium	Steam, water, glycol
Body Type	Screwed ends 2" and smaller, flanged valves 2½ " and larger
Body Material	Bronze
Body Trim	Bronze
Shut-off Disk on 2-way	Replaceable 2" EPT, 2" Composition
Shut-off Disk on 3-way	Replaceable 2" EPT, 2" Bronze
Stem	Stainless Steel
Actuator	0-10 VDC, 4-20 MA or 2 position 24 vAC/120 VAC

- B. All automatic temperature control valves in water lines shall be provided with characterized throttling plugs and shall be sized for minimum 25% of the system pressure drop or 5 psi, whichever is less.
 - 1. Provide control valves with close off pressure suitable for pressure encountered.
 - 2. Two position valves shall be line size.

2.04 DAMPER ACTUATORS

- A. Electric control shall be Siemens Building Technologies open air direct coupled actuators.
- B. Damper actuators shall be Brushless DC Motor Technology with stall protection, bi-directional, fail safe spring return, all metal housing, manual override, independently adjustable dual auxiliary switch.
 - 1. The actuator assembly shall include the necessary hardware and brackets to allow proper mounting and connection to a standard 1/2 inch diameter shaft or damper blade.

2.05 MISCELLANEOUS DEVICES

- A. Thermostats
 - 1. Room thermostats shall be of the gradual acting type with adjustable sensitivity.
 - 2. They shall have a bi-metal sensing element capable of responding to a temperature change of one-tenth of one degree. (Provide all thermostats with limit stops to limit adjustments as required.)
 - 3. Thermostats shall be arranged for either horizontal or vertical mounting.
 - 4. In the vertical position thermostat shall fit on a mullion of movable partitions without overlap.
 - 5. Mount the thermostat covers with tamper-proof socket head screws.
- B. Freezestats:
 - 1. Install freezestats as indicated and provide protection for every square foot of coil surface area with one linear foot of element per square foot of coil.
 - a. Upon detection of low temperature, the freezestats shall stop the associated supply fans and return the automatic dampers to their normal position. Provide manual reset.
- C. Firestats:
 - 1. Provide manual reset, fixed temperature line voltage type with a bi-metal actuated switch.
 - a. Switch shall have adequate rating for required load.

D. Airflow Measuring Station

1. Each station shall contain parallel air straightener, total and static pressure sensing manifolds, internal piping and external pressure transmission ports with flexible tubing and quick-connect fittings. Fabricate of galvanized steel, size for fan inlet or duct system in which mounted. Maximum pressure loss through station of 0.08 inches water gage at 1500 fpm. Station shall have accuracy of 2%. Identify by model number, size, area, and specified airflow capacity.

E. Current Sensing Relay:

1. Provide solid-state, adjustable, current operated relay. Provide a relay which changes switch contact state in response to an adjustable set point value of current in the monitored A/C circuit.
2. Adjust the relay switch point so that the relay responds to motor operation under load as an "on" state and so that the relay responds to an unloaded running motor as an "off" state. A motor with a broken belt is considered an unloaded motor.
3. Provide for status device for all fans and pumps.

F. Automatic Dampers

1. Balanced type with pressed or elliptical steel blades with interlocking edges, mounted horizontally in welded steel frames. Rectangular dampers 12 inches or more in direction perpendicular to axis shall be louvered, with blades not over 8 inches wide. Provide steel trunnions in bronze sleeve bearings or ball bearings. Dampers shall be not more than 48 inches in length between bearings.
2. Dampers shall close with 10 CFM/SF maximum leakage at 4 in. WG differential pressure and provide substantially full area of opening when open. Dampers shall have neoprene edges and end seals cemented and riveted in place during fabrication.
3. Modulating dampers shall be opposed blade type. Two position dampers shall be parallel blade type.
4. Damper blade linkages including operating rods bearings and operator mounting plates shall be designed to withstand twice the required operator force without deflection. Provide for field adjustment of full open position.
5. Acceptable Product: Ruskin CD-35, Penn or Arrow, or Approved Equal.

2.06 TRANSMISSION NETWORK

A. Distributed Communication Processor.

1. The system shall use an intelligent Distributed Communication Processor (DCP).
 - a. It may be a wall-mounted or desk-top unit.
 - b. This processor shall be microprocessor based and shall interface the central processing unit and remote units or modular building controllers.

- c. The transmission shall be asynchronous and utilize a token-pass networking method.
- d. The system shall utilize a cyclic redundancy check or dual transmission with parity check to ensure signal reliability.
- e. The network will support up to 100 modular building controllers and additional associated multiple and digital point units.
- f. The transmission network shall utilize a twisted shielded pair.
- g. The transmission speed shall be a minimum of 19.2K baud and operate in a half-duplex mode.

2.07 MODULAR BUILDING CONTROLLERS AND ACCESSORIES

- A. The system shall utilize intelligent distributed Modular Building Controllers (MBC) to interface sensors being monitored and equipment being controlled by the facility management and control system.
 - 1. Each unit shall be microprocessor based and perform the following functions:
 - a. Acquire, process, and transfer information to the central computer, network computer, or other remote units.
 - b. Accept, process, and execute commands from the central computer, network computer, other remote units or other input devices.
 - c. Record, evaluate, and report changes of state and/or value that occur among points associated with the remote unit.
 - d. Locally perform direct digital control (DDC) of all common mechanical system functions, such functions shall be programmed using a sequential, numbered statement programming language (See Software.)
 - e. Support Local Area Network (LAN) trunks.
 - f. Each MBC shall execute all applicable program, calculations and commands via a 16-bit microcomputer resident in the unit.
 - g. The microcomputer shall permit floating point calculations to enable the performance of energy calculations.
 - h. Each MBC shall contain a real-time clock to enable the unit to automatically perform time based functions.
 - i. Each control unit shall be capable of full operation either as a completely independent unit or as a part of the building-wide control system.
 - 1) All units shall contain the necessary equipment for direct interface to the sensors and actuators connected to it.
 - 2) Control strategies shall be user definable at multiple control unit locations, and for all control units in the system from any one operator terminal.

- j. Each modular building controller shall include its one microcomputer direct digital controller, power supply, input/output modules, and battery.
 - 1) The battery shall be self-charging and be capable of supporting all memory within the control unit if the commercial power to the unit is interrupted or lost for a minimum of 60 days. Provide low battery alarm at the operator's station.
- k. Each unit shall perform continuous diagnostics, and any malfunction shall be annunciated at the operator's console as well as visually indicated at the remote unit.
 - 1) Failure of any unit on the system shall not affect the proper operation of the remaining system components.
- l. The system shall be capable of phased start-up.
 - 1) That is, any unit shall be capable of properly communicating with the rest of the system while remaining units are being installed.
- m. Surge transient protection shall be provided in each unit for the purpose of suppressing inducted voltage transients.
- n. All units shall be listed by Underwriters Laboratories (UL) against fire and shock hazard as a signal system appliance unit.
- o. The unit shall also be listed by UL Canada (ULC) and Canadian Standards Association (CSA).
- p. Units shall have all metal cabinets.
 - 1) Each unit including cabinet, power supply, function cards and termination modules shall be approved by UL.
- q. Each unit shall have a pin-hinged door and master keyed lock.
 - 1) Remote units shall be capable of proper operation in an ambient environment of 32 degrees F and 10% to 90% RH.

B. Input/Output Types:

- 1. Each modular building controller shall be capable of accepting multiple point inputs and outputs.
- 2. These shall be of four types corresponding to industry nomenclature.
- 3. They are as follows:
 - a. DIGITAL IN for monitoring status, alarms and accumulating pulses.
 - b. DIGITAL OUT for commanding two and three state devices.
 - c. ANALOG IN for measuring values.
 - d. ANALOG OUT for positioning set points.
 - 1) Provide individual manual positioning switch and analog gauge for each analog outputs at the DDC cabinet.
- 4. It shall be possible for each unit to monitor the following type of inputs, without the addition of equipment outside the unit cabinet:

- a. Analog inputs.
 - 1) 4 - 20 ma.
 - 2) Thermistors.
 - 3) RTD.
- b. Digital inputs.
 - 1) Dry contact closure.
 - 2) Pulse accumulator.
5. The control unit shall directly control actuators and control devices.
6. Each control unit shall be capable of providing the following control outputs without the addition of equipment outside the remote unit cabinet:
 - a. Digital outputs (contact closure).
 - 1) Motor starters, sizes 1-4.
 - b. Analog outputs.
 - 1) 4-20 mA.
 - 2) 0 - 10 vDC.
7. Provide manual override switch at the modular building controller for each digital-out and analog-out point. The digital-out switch will be a hand-off-auto and the analog-out switch a hand-auto with a gradual position switch. DDC system will supervise the position of the override switch for the central operator.

C. Operator Interface:

1. The facility management and control system shall permit full operator communication including obtaining information about the performance of his system; allowing the operator to change the system operation; and diagnosing system malfunctions.
2. Operator communication shall be through the use of any one of the following operator terminals which can be directly connected to the modular building controller. Provide two RS-232 serial data communication ports per modular building controller.

D. User Programmability:

1. All temperature control strategies and energy management routines shall be definable by the operator through an operator's terminal or a portable programming unit.
2. The system shall be provided complete with all equipment and documentation necessary to allow a trained operator to independently perform the functions listed below:
 - a. Start or stop equipment.
 - b. Monitor the status of equipment being controlled.
 - c. Read the set point of a control loop.

- d. Determine the control strategies that have been defined for a specific piece of equipment.
 - e. Generate displays of control strategies.
 - f. Add/delete control loops to the system.
 - g. Add/delete points to the system.
 - h. Create, modify or delete control strategies.
 - i. Assign sensors and/or actuators to a control strategy.
 - j. Tune control loops through the adjustment of control loop parameters.
 - k. Enable or disable control strategies.
 - l. Generate hard copy records of control strategies on a printer.
 - m. Select points to be alarmable and define the alarm state(s).
- E. Self-Diagnostics and Alarm Reporting:
- 1. Each modular building controller shall contain self-diagnostics that continuously monitor the proper operation of the unit.
 - 2. A malfunction of the unit will be reported, and will inform the operator of the nature of the malfunction and the control unit affected.
 - 3. It shall be possible to annunciate malfunctions as well as other control unit alarms at a selected operator's terminal.

2.08 COMPUTER SOFTWARE

- A. Point Database:
- 1. Logical point names, point descriptions and engineering units shall be operator definable on a per point basis.

2.09 EQUIPMENT CONTROLLERS FOR AIR TERMINAL UNITS (VARIABLE AND CONSTANT VOLUME BOXES)

- A. Provide for control of each Air Terminal Unit.
- B. Controllers shall include all point inputs and outputs necessary to perform the specified control sequences. Analog outputs shall be industry standard signals such as 24V floating control, allowing for interface to a variety of modulating actuators. Terminal equipment controllers utilizing proprietary control signals and actuators shall not be acceptable.
- C. Each controller performing space temperature control shall be provided with a matching room temperature sensor. The sensor may be either RTD or thermistor type providing the following minimum performance requirements are met:
- 1. Accuracy: $\pm 1^{\circ}\text{F. } (\pm 0.55^{\circ}\text{C}).$

2. Operating Range: 35°F to 115°F. (2°C to 46°C.)
3. Set Point Adjustment Range: 55°F to 95°F. (2°C to 30°C).
4. Set Point Modes: Independent Heating, Cooling,
5. Calibration Adjustments: None Required.
6. Installation: Up to 100 ft. from controller.
7. Each room temperature sensor shall include a terminal jack integral to the sensor assembly. The terminal jack shall be used to connect a portable operator's terminal to control and monitor all hardware and software points associated with the controller. In lieu of an internal jack, provide a separate terminal jack mounted on a stainless steel wall plate adjacent to the sensor to facilitate direct access to the controller via the terminal.
8. Each room sensor shall also include the following auxiliary devices:
 - a. Temperature Indicator with Digital Display.
9. The temperature indicator shall be a bi-metal or mercury thermometer and shall be visible without removing the sensor cover. In lieu of integral indication, provide a separate thermometer or digital readout mounted on a stainless steel wall plate adjacent to the sensor for local temperature indication.

- D. Each controller shall perform its primary control function independent of other EMCS LAN communication, or if LAN communication is interrupted. Reversion to a fail-safe mode of operation during LAN interruption is not acceptable. The controller shall receive its real-time data from the EMCS time clock to insure LAN continuity. Each controller shall include algorithms incorporating proportional, integral and derivative (PID) gains for all applications. All PID gains and biases shall be field-adjustable by the user via terminals as specified herein. This functionality shall allow for tighter control of space conditions and shall facilitate optimal occupant comfort and energy savings. Controllers that incorporate proportional and integral (PI) control algorithms only shall not be acceptable.
- E. Provide each terminal equipment controller with sufficient memory to accommodate point databases, operating programs, local alarming and local trending. All databases and programs shall be stored in non-volatile EEPROM, EPROM and PROM, or minimum of 72-hour battery backup shall be provided. The controllers shall be able to return to full normal operation without user intervention after a power failure of unlimited duration. Provide uninterruptible power supplies (UPSS) of sufficient capacities for all terminal controllers that do not meet this protection requirement. Operating programs shall be field-selectable for specific applications. In addition, specific applications may be modified to meet the user's exact control strategy requirements, allowing for additional system flexibility. Controllers that require factory changes of all applications are not acceptable.

- F. Constant and Variable Air Volume Box Controllers: Shall support the following types of pressure independent terminal boxes as a minimum:
1. Air Terminal Unit with Hot Water Reheat.
 2. Cooling Only Unit.
 3. All Air Terminal Unit control applications shall be field-selectable such that a single controller may be used in conjunction with any of the above types of terminal units to perform the specified sequences of control. This requirement must be met in order to allow for future design and application changes and to facilitate system expansions. Controllers that require factory application changes are not acceptable.
 4. The Air Terminal Unit controllers shall be powered from a 24 VAC source and shall function normally under an operating range of 18 to 28 VAC (-25% to +17%), allowing for power source fluctuations and voltage drops. The EMCS contractor shall provide a dedicated power source and separate isolation transformer for each controller unable to function normally under the specified operating range. The controllers shall also function normally under ambient conditions of 32 degrees to 122 degrees F. (0 degrees to 50 degrees C) and 10% to 95% RH (non-condensing). Provide each controller with a suitable cover or enclosure to protect the intelligence board assembly.
 5. The controller shall include a differential pressure transducer that shall connect to the terminal unit manufacturer's standard averaging air velocity sensor to measure the average differential pressure in the duct. The controller shall convert this value to actual air flow. Single point air velocity sensing is not acceptable. The differential pressure transducer shall have a measurement range of 0 to 400 fpm (0 to 20.4 m/s) and measurement accuracy of +/- 5% at 400 to 400 fpm (2 to 20 m/s), insuring primary air flow conditions shall be controlled and maintained to within +/- 5% of set point at the specified parameters. The EMCS contractor shall provide the velocity sensor if required to meet the specified functionality.
 6. Each controller shall include provisions for manual and automatic calibration of the differential pressure transducer in order to maintain stable control and insuring against drift over time. Calibration shall be accomplished by stroking the terminal unit damper actuator to a 0% position so that a 0 CFM air volume reading is sensed. The controller shall automatically accomplish this whenever the system mode switches from occupied to unoccupied or vice versa. Manual calibration may be accomplished by either commanding the actuator to 0% via the POT or by depressing the room sensor override switch. Calibration of the transducer at the controller location shall not be necessary.
 7. The Air Terminal unit controller shall interface to a matching room temperature sensor as previously specified. The controller shall function to maintain space temperature within tolerances as previously specified at the room sensor location.

PART 3 EXECUTION

3.01 EMCS WIRING

- A. General:
 - 1. All EMCS input/output signal wiring shall be in EMT metal conduit.
 - 2. All low voltage wiring shall be in EMT metal conduit.
 - 3. EMCS contractor to provide all power wiring as required by their system.
 - 4. Route conduits in parallel banks with all changes of direction made at 90 degree angles.
 - 5. In addition, all wiring passing within 15 feet (in any direction) of the center of all Quiet and Ultra-Quiet Rooms shall be installed in rigid conduit. With the following exception:
 - a. Ultra Quiet Room Space Temperature Sensor
- B. Locate, size and support temperature sensing elements in air streams to properly sense the representative temperature.
 - 1. In the case of controlling transmitting and indicating elements, locate the sensing device, sized and of the type to sense the average conditions.
 - 2. In the case of safety elements, locate the sensing device and of the type to sense the extreme condition.
 - 3. Sensing elements in double wall casings and insulated cuts shall have the entire active portion within the air stream.
- C. Install temperature sensing elements in fluid lines and vessels with Type 304 stainless steel or monel wells filled with a non-solidifying heat conducting paste.
 - 1. Locate sensing elements such that they are in the path of moving fluid and not positioned in stagnant or dead end locations.
 - 2. Wells shall not obstruct the flow of the fluid being measured.
 - 3. Increase all pipes 1 inch and smaller at least one (1) pipe size at the point of insertion.
- D. Where insulation on piping, ductwork, or equipment is punctured or penetrated due to the installation of sensing elements or tubing, reseal the openings air and vapor tight.
 - 1. Where control devices are to be located on insulated surfaces, provide brackets to clear the finished surface of the insulation voiding punctures of the vapor seal.
- E. Locate, support, enclose, and install control devices and equipment such that they will not be subject to vibration, excessive temperatures, dirt, moisture, or other harmful effects or conditions beyond their rated limitations.

- F. Check and verify location of thermostats and other exposed control sensors with plans and room details before installation.
 - 1. Locate thermostats 60 inches above the floor.
- G. Interlock alarms with starter switching to bypass alarm when equipment is manually disconnected.
- H. Conceal sensing lines, cables, capillaries, and so forth, in all areas except equipment rooms, and other unfinished spaces.
- I. Route sensing lines, cables, capillaries, and so forth, in all areas except equipment rooms, and other unfinished spaces.
- J. Install control valves horizontal with power unit up unless indicated otherwise.
- K. Install pressure sensing elements in ducts and casings with clean sharp taps to accurately read true static pressure avoiding velocity and turbulence influences.
- L. Control valve and damper operators shall be capable of smoothly positioning under load through the full ranges and strokes indicated in both directions without binding or fluttering and shall be further capable of holding steady in any intermediate or extreme position while the respective systems are functioning at design flows, temperatures, and pressures.

3.02 COMPLETION OF INSTALLATION

- A. Provide all necessary relays, switches, valves, brackets, linkages, control devices, auxiliaries, fasteners, accessories, and connections to result in complete and operable control system shown on the drawings and specified.

3.03 CALIBRATION AND ADJUSTMENT

- A. Calibrate and adjust all control devices, linkages, accessories, and components for stable and accurate operation to meet the design intent of the specifications and drawings and to obtain optimum performance from the equipment controlled.
- B. Perform the final adjustment, calibration, and checking while the respective controlled systems are in full operation.
 - 1. Cause every device to automatically function as intended to insure its proper operation.

3.04 INSTRUCTIONS TO OPERATIONS PERSONNEL

- A. Upon completion of the work a factory representative under direct employ of the temperature control manufacturer shall provide a total of 32 hours of instruction to operating personnel who have responsibility for the mechanical system.

3.05 COMMISSIONING:

- A. Provide all material and labor required to fulfill the commissioning requirements as described in Section 15995, COMMISSIONING OF MECHANICAL SYSTEMS, and the Commissioning Plan included in Appendix B.

3.06 PERFORMANCE VERIFICATION TEST(PVT)

- A. Provide the following to serve as the system performance verification test and turn over to the ROICC for their review.
 - 1. provide trend logs of analog points that are used for actual control. Including temperature, pressure and flow points. Provide required set point information and actual trend values.

END OF SECTION

SECTION 15940

HVAC SEQUENCE OF OPERATION

PART 1 GENERAL

1.01 SUMMARY

- A. This Section defines the manner and method by which controls function. Requirements for each type of control system operation are specified. Equipment, devices, and system components required for control systems are specified in other Sections.
- B. Section Includes:
 - 1. Sequence of operation for:
 - a. Humidifiers.
 - b. Space Pressure Controls
 - c. Terminal Air Units.
 - d. Central Air Handling Systems.
- C. Related Sections
 - 1. Section 15910 – Energy Management and Control System.
 - 2. Section 15990 – Commissioning of Mechanical Systems.

1.02 SYSTEM DESCRIPTION

1.03 SUBMITTALS

- A. Shop Drawings: Indicate mechanical system controlled and control system components.
- B. Label with settings, adjustable range of control and limits.
- C. Include written description of control sequence.
- D. Include flow diagrams for each control system, graphically depicting control logic.
- E. Include draft copies of graphic displays indicating mechanical system components, control system components, and controlled function status and value.
- F. Project Record Documents: Record actual locations of components and set points of controls, including changes to sequences made after submission of shop drawings.

1.04 QUALITY ASSURANCE

- A. Design system under direct supervision of a Professional Engineer experienced in design of this Work and licensed in the District of Columbia.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 CONTROL SEQUENCES

- A. Clean Room Units 7 and 8: The re-circulating air handling unit consists of a primary air section with pre-filter, final filters, humidifier, chilled water cooling coil, supply fan with variable frequency drive. A smoke detector is located in the supply air duct of each unit. The unit is DDC controlled using electric actuation.
1. Normal On: The fan starts or continues to run. The cooling coil valve modulates to maintain the space temperature set point of 68 degrees F. (20 degrees C.). Supply Air Flow Measuring Station through the DDC system shall control the supply fan variable frequency drive to maintain a constant volume of air supply. The controls shall provide for an input change in total design supply airflow based on a revised CFM set point as determined by operator. This change in set point will result in VFD speed regulation to maintain revised set point. Airflow shall be measured and controlled by a flow measuring station at the plenum fan inlet.
 2. Normal Off: The supply fan stops. The cooling coil valve closes. The humidifier valve closes.
 3. Humidifier control: The room mounted humidity sensor will modulate the humidifier control valve to maintain room humidity set point of 45% RH. Humidifier shall not operate without confirmed airflow. Humidifier valve modulates closed if supply air humidity levels at high limit sensor exceed set point and alarm shall be initiated.
 4. Safety: Smoke detector in the supply air stream shall de-energize the supply fan upon activation and send an alarm signal to the building DDC system. Provide hard-wired connections for the safety device. The cooling coil valve positions to its normal position after the fan is de-energized. The VFD status contact is installed in the supply fan VFD. The DDC system uses the contact to confirm the fan is in the desired state (i.e. on or off) and generates an alarm if status deviates from DDC start/stop control.
- B. Outside Air VAV Box w/ HW Reheat (for AHU 7 and 8): The variable volume (VAV) terminal unit and the reheat valve are controlled independent of system pressure fluctuations by an application specific DDC controller using electric actuation. An autozero module is provided for periodic calibration of the controller air velocity transducer. The VAV terminal unit and the reheat valve is controlled in Normal On mode as follows:
1. Normal On: The VAV terminal unit is controlled within user defined maximum and minimum supply air volume settings. The fume hoods PLC provides an output signal to the terminal box controller to adjust the supply air volume, so that the supply air volume tracks with the exhaust air fan control as required by the fume hoods PLC controller. The cooling coil valve in AHU 7 and 8 shall modulate closed first. If space temperature is still below set point the VAV reheat coil valve shall modulate open to maintain space temperature.

- C. Cleanroom Pressure Relief: The north and south side of the cleanroom shall have a pressure relief damper in a transfer duct located above the Control Monitoring Room 102 and the Utility Room 101. Pressure relief dampers shall be normally closed. If the pressure differential should rise above 0.15 inches w.g. (37 Pa) adjustable the motor operated control damper shall modulate open to maintain the set point (adjustable).

3.02 EXHAUST FANS

- A. Exhaust fans shall be controlled by the DDC system. Exhaust fan will energize when the air-handling unit associated with that area goes into the normal on mode of operation and de-energize during the normal off mode of operation.

3.03 OBJECT LIST

- A. The minimum object (points) list to be furnished by the ATC Contractor is shown on the drawings.
- B. At a minimum, each of these points shall be communicated from the lower level ATC system to the operator workstation provided under Section 15910.

END OF SECTION

SECTION 15950

TESTING, ADJUSTING AND BALANCING

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: The work specified in this Section consists of the testing, adjusting and balancing of air and hydronic systems.

1.02 REFERENCES

- A. National Environmental Balancing Bureau (NEBB): Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems.
- B. Associated Air Balance Council (AABC): National Standards for Total System Balance.
- C. Sheet Metal and Air Conditioning Contractors National Association (SMACNA): HVAC Systems Testing, Adjusting and Balancing.
- D. American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE) ASHRAE Handbook-HVAC Systems and Applications, Chapter 57, Testing, Adjusting and Balancing 1987 Edition.

1.03 SUBMITTALS

- A. Include testing and balancing information as follows:
 - 1. TAB Agency certification.
 - 2. TAB report forms to be used:
 - a. System schematics and diagrams.
 - b. Air Apparatus Test Report.
 - c. Apparatus Coil Test Report.
 - d. Fan Test Report.
 - e. Rectangular Duct Traverse Report.
 - f. Round Duct Traverse Report.
 - g. Air Outlet Test Report.
 - h. Terminal Unit Coil Check Report.
 - i. Noise Level Report
 - j. TAB Instrument Calibration Report.
 - k. Modular Wet Station Hood Reports.

2. Design review report and work plan:
 - a. Describe omissions and deficiencies in the HVAC system's design that would preclude the TAB work from being accomplished in conformance with the requirements of this section. List such deficiencies with explanation. If no such deficiencies are evident, state this.
 - b. Describe the method of approach to accomplish the TAB field work from start to finish. List all procedural steps to be taken to accomplish the required TAB work for each air distribution system and each water distribution system.
 - c. List the types of instruments and the measuring range of each, which are anticipated to be used in the TAB field work
 - d. Designate the actual data to be measured in the TAB field work. Include the location of planned pilot traverses of duct mains and branches.

2.02 QUALITY ASSURANCE

- A. Equipment and Instruments: Use test instruments recently calibrated within instrument manufacturer's time frame and checked for accuracy prior to start of testing, adjusting and balancing.
- B. Provide the services of an independent certified Test and Balance Agency hereinafter called the Agency, which agency specializes in testing, adjusting and balancing HVAC systems, to test, adjust and balance equipment and systems as indicated on the Drawings.
 1. The Agency shall provide instruments and testing equipment required to perform the work as specified herein and shall notify the Project Manager of the dates and times when he intends to perform the work.
 2. The Agency shall guarantee the proper operation of the systems installed in this project to be operating in accordance with designed requirements by testing, adjusting and balancing such systems. Perform the TAB work in accordance with the procedures and standards described in the above references.
 3. The Agency must be a certified member of the Associated Air Balance Council, or National Environmental Balancing Bureau.
 4. The Agency shall include a one year warranty to begin on the Acceptance and Final Payment date, during which time the ROICC may request rechecking and/or resetting equipment, devices, or flow rates.
 5. Provide technicians to assist the ROICC in making any tests that may be required during the warranty period.
 6. The Agency must be one who has successful experience in a project of the same relative size, and design for a period of a minimum of three years.

PART 3 PRODUCTS

NOT USED

PART 4 EXECUTION

4.01 PRELIMINARY PROCEDURES

- A. Obtain and review design Drawings and Specifications of the HVAC Contract and become familiar with the design requirements.
- B. Obtain and review copies of approved shop drawings and operation and maintenance manuals of mechanical equipment, devices, and temperature control diagrams.
- C. Inspect systems when rough-in is complete:
 - 1. Prior to concealment of any ductwork or piping, verify that fittings, dampers, control devices, test devices, measurement devices, and valves are properly located and installed.
 - 2. Examine each system to determine variations of installation differing from the Drawings.
- D. Examine each air and hydronic system to see that it is free from obstructions. Determine that dampers, registers and valves are in a set or full open position; that moving equipment is lubricated; and that required filters are installed, clean and functioning. Report system deficiencies to the Contractor for correction.
- E. Do not start TAB work until water-side systems are completed and filled, ready for start-up. Do not perform work when danger of freezing exists in any part of the system.
- F. Perform before-start-up inspections and maintenance activities as required by the respective equipment manufacturers for proper operation of their equipment.
- G. Check temperature control system for completeness of installation before starting TAB work.
- H. Prepare schematic diagrams of as-built systems for reporting. Include schematics and diagrams in TAB report.

4.02 TAB PROCEDURE

- A. Place equipment in operation and verify that equipment performs as specified.
- B. Adjust variable type drives, volume dampers, control dampers, balancing valves and control valves as required for each system to perform as intended; calibrate differential pressure controllers to meet system requirements.
- C. Adjust each register, diffuser and terminal unit to handle and properly distribute the design airflow within 10 percent of the indicated quantities.

- D. Adjust balancing valves so that each heating/cooling coil is furnished with the design fluid flow within 10 percent of the indicated quantity.
- E. Measure sound pressure levels in each of the eight unweighted octave bands and plot NC curve for Clean Rooms No. 7 and No. 8 and each room where noise level criteria is specified by the RFP. Clean Room noise level is limited to NC55-60.
- F. Document the results of testing on TAB report forms as previously approved by the Project Manager and submit for approval and record.
- G. Where gauges or other flow indicators are not provided, perform balancing by air-side correlation as described in the referenced ASHRAE Handbook.
- H. Make adjustments to temperature control devices only with assistance or supervision of temperature control installer.

4.03 FIELD QUALITY CONTROL

- A. Deficiencies and defects manifested by the above TAB work must be rectified by the Contractor in a method approved by the COR at no increase in Contract Price.
- B. Finally the Agency shall leave the systems in operation under their respective controls.

END OF SECTION

SECTION 15990

COMMISSIONING OF MECHANICAL SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: The work specified in this Section consists of commissioning of Mechanical systems that are part of this project.

1.02 REFERENCES

- A. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)
 - 1. ASHRAE Guideline 1 – 1996: The HVAC Commissioning Process

1.03 SUBMITTALS

- A. The following shall be submitted:
 - 1. Commissioning Team
 - a. List of team members who will represent the Contractor in the pre-commissioning checks and functional performance testing, at least 2 weeks prior to the start of commissioning checks. Proposed revision to the list, prior to the start of the impacted work.
 - 2. Commissioning Plan
 - a. Commissioning plan shall include narrative describing the scope and method of testing. The commissioning plan shall indicate the approximate time period during which testing shall take place.
 - 3. Test Procedures
 - a. Detailed procedures for commissioning checks and functional performance tests, at least 4 months prior to the start of pre-commissioning checks.
 - 4. Schedules
 - a. Test Schedule.
 - b. Schedule for pre-commissioning checks and functional performance tests, at least 2 weeks prior to the start of commissioning checks.
 - 5. Test Reports.
 - a. Completed commissioning checklists and functional performance test checklists organized by system and by subsystem and submitted as one package. The results of failed tests shall be included along with a description of the corrective action to be taken. Failed test shall be retested after corrective action has been taken and retest until resolution is reached.

1.04 SEQUENCING AND SCHEDULING

- A. The work described in this Section shall begin only after all work required in related Sections, has been successfully completed, and all test and inspection reports required in these Sections have been submitted and approved.

PART 2 PRODUCTS – NOT USED

PART 3 EXECUTION

3.01 COMMISSIONING TEAM AND CHECKLISTS

- A. The Contractor shall designate team members to participate in the pre-commissioning checks and the functional performance testing specified herein. The team members shall be as follows:

B. Designation	Function
1. CA	Commissioning Agent
2. CQ	Contractor's Chief Quality Control Representative
3. CM	Contractor's Mechanical Representative
4. CE	Contractor's Electrical Representative
5. CT	Contractor's Testing, Adjusting, and Balancing Representative
6. CC	Contractor's Controls Representative
7. GC	General Contractor
8. O/U	Owner' or User's Representatives

- C. All checklists and test included in the commissioning plan shall be completed by the commissioning team. Acceptance by each commissioning team member of each commissioning checklist and test item shall be indicated by initials and date unless participation by that individual is not required. Acceptance by each commissioning team member of each functional performance test checklist shall be indicated by signature and date.
- D. Each checklist shown shall be completed by the commissioning team. Acceptance by each commissioning team member of each pre-commissioning checklist item shall be indicated by initials and date unless participation by that individual is not required. Acceptance by each commissioning team member of each functional performance test checklist shall be indicated by signature and date.

3.02 TESTS

- A. The commissioning checks and functional performance tests shall be performed in a manner which essentially duplicates the checking, testing, and inspection methods established in the related Sections. Where checking, testing, and inspection methods are not specified in other Sections, methods shall be established which will provide the information required. Testing and verification required by this section shall be performed during the Commissioning phase. Requirements in related Sections are independent from the requirements of this Section and shall not be used to satisfy any

of the requirements specified in this Section. The Contractor shall provide all materials, services, and labor required to perform the pre-commissioning checks and functional performance tests. A commissioning check or functional performance test shall be aborted if any system deficiency prevents the successful completion of the test or if any participating commissioning team member of which participation is specified is not present for the test.

B. Commissioning Checks

1. Commissioning checks shall be performed for the items indicated on the checklists in commissioning plan. Deficiencies discovered during these checks shall be corrected and retested in accordance with the applicable contract requirements.

C. Functional Performance Tests

1. Functional performance tests shall be performed for the items indicated on the checklists in commissioning plan. Functional performance tests shall begin only after all pre-commissioning checks have been successfully completed. Tests shall prove all modes of the sequences of operation, and shall verify all other relevant contract requirements. Tests shall begin with equipment or components and shall progress through subsystems to complete systems. Upon failure of any functional performance test checklist item, the Contractor shall correct all deficiencies in accordance with the applicable contract requirements. The checklist shall then be repeated until it has been completed with no errors.

3.03 COMMISSIONING REPORT

A. Final Report

1. The final commissioning report shall include:
 - a. Commissioning Plan
 - b. Complete checklist including factory start-up reports where applicable.
 - c. Complete functional performance test with results
2. Submission
 - a. The final report shall be bound in a three ring binder and presented to the owner as a record of system performance and procedures verification.

END OF SECTION

SECTION 15995

CLEANROOM CERTIFICATION

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: The work specified in this Section consists of services and work of an administrative nature as well as general requirements concerning the certification of cleanrooms.
- B. Related Sections:
 - 1. Division 15950: Testing, Adjusting and Balancing
 - 2. Division 13050: Cleanroom Ceiling Systems.

1.02 REFERENCES

- A. Institute of Environmental Sciences and Technology (IEST): Qualifications for Agencies and Personnel Engaged in the Testing and Certification of Clean Rooms and Clean Air Devices, IEST-RP-CC019.
- B. Institute of Environmental Science and Technology (IEST): Testing Cleanrooms, IEST-RP-CC006.2.
- C. Federal Standards (FED-STD): Airborne Particulate Cleanliness Classes in Cleanrooms and Clean Zones, FED-STD 209.

1.03 SUBMITTALS

- A. As specified in Section 15010, submittals required within thirty days after receipt of contract for the following items:
 - 1. Certification Agency corporate qualifications and experience submittal including description of certification work completed on similar projects, references names and phone numbers and resumes of management personnel responsible for this project.
- B. As specified in Section 15010, submittals required for:
 - 1. Certification test data on filters.
 - 2. Certification test data on cleanroom areas.
 - 3. Certification instrument calibration report.

1.04 QUALITY ASSURANCE

- A. Equipment and Instruments: Use test instruments recently calibrated within instrument manufacturer's time frame and checked for accuracy prior to start of certification.

- B. Provide services of an independent certification agency hereinafter called the Agency, which specializes in certification of cleanrooms.

PART 2 PRODUCTS

2.01 AGENCIES

- A. (By Contractor)

PART 3 EXECUTION

3.01 PRELIMINARY PROCEDURES

- A. Obtain and review design Drawings and Specifications of the HVAC Contract and become familiar with the design documents.
- B. Obtain and review a copy of the Test, Adjusting and Balance report as it relates to cleanroom air systems.
- C. Do not start certification work until Testing, Adjusting and Balancing work is complete.

3.02 AIRFLOW VELOCITY, VOLUME AND UNIFORMITY TESTS

- A. Perform airflow velocity, volume and uniformity tests in accordance with Section 6.1 of IEST-RP-CC006.2.
- B. Acceptance criteria for cleanrooms is:
 - 1. Clean Rooms 104: 60 CFM per square foot plus or minus 10%. Convert the indicated volumetric flow rate to an equivalent velocity based on actual filter media area and measure velocity at the entrance plane to the work zone, 12 inches from the filter face.

3.03 HEPA FILTER INSTALLATION LEAK TESTS

- A. Perform HEPA filter installation leak tests in accordance with Section 6.2 of IEST-RP-CC006.2.
- B. Acceptance criteria is no leak greater than that stated in Section 6.2.1.c. Filter repair is acceptable within the limits of Section 6.2.1.d.

3.04 AIRBORNE PARTICLE COUNT

- A. Perform airborne particle count tests in accordance with Section 6.3 of IEST-RP-CC006.2.

- B. Acceptance criteria for cleanrooms is:
 - 1. Clean Room 104: Class 100 as defined in FED-STD-209. Perform tests in an “as-built” condition as defined in IEST-RP-CC006.2.

3.05 ROOM PRESSURIZATION TEST

- A. Perform room pressurization tests in accordance with Section 6.4 of IEST-RP=CC006.2
- B. Acceptance criteria between cleanrooms is:
 - 1. Clean Room 104 to Clean Room 103: minimum of plus .03 inches of water gauge.

3.06 FIELD QUALITY CONTROL

- A. Deficiencies and defects manifested by the above certification work must be rectified by the Contractor in a method approved by the Project Manager at no increase in Contract Price.

END OF SECTION

SECTION 16010

BASIC ELECTRICAL REQUIREMENTS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: The work specified in this Section consists of services and work of an administrative nature as well as general requirements concerning certain products and operations, all common to the entire Division 16 Sections.
- B. Related Sections:
 - 1. Painting: Section 09900.

1.02 REFERENCES

- A. Reference Standards: The following standards, as referenced throughout the Sections of Division 16, along with all associated addenda and/or revision thereto, shall serve as the minimum standards and requirements directly appropriate to the work and workmanship.
 - 1. American National Standards Institute:
 - a. ANSI C1, National Electrical Code.
 - b. ANSI C2, National Electrical Safety Code.
 - 2. Insulated Cable Engineers Association (ICEA) Standards for Wire and Cable and the testing thereof.
 - 3. National Electric Manufacturer's Association (NEMA) Standards of Construction.
 - 4. American National Standards Institute (ANSI) Standards of Equipment.
 - 5. American Society for Testing Materials (ASTM) Standards for Equipment Testing.
 - 6. Institute of Electrical and Electronics Engineers (IEEE) Standards for Equipment.
 - 7. Underwriters' Laboratories (UL) Listings on specified Products.
 - 8. Guidelines for seismic restraints of mechanical/plumbing piping and electrical systems.

1.03 QUALITY ASSURANCE

- A. Regulatory Requirements: The construction code requirements of Utility Companies or political subdivisions, which exceed the requirements of national codes, standards and approving bodies, shall be met and complied with. Modify the electrical work to be in conformity with such laws, ordinances, rules and regulations without additional expense to the Government.

- B. Source Quality Control: Products used throughout these Specifications and as indicated on the Drawings are those of companies having established reputations in the manufacture of the particular materials, equipment or apparatus specified. Such products shall be of their own make, or products of others, for which the manufacturer assumes full responsibility for products used in said outfits which are not manufactured completely by them, and with replacement parts available.
- C. U.L. Listing: Products shall be U.L. listed where possible; i.e., where products of like design, function and appearance have been submitted and have received the U.L. Label. Products shall also be labeled for the specific use intended and the location where it shall be installed.

1.04 DELIVERY, STORAGE AND HANDLING

- A. Packing, Shipping, Handling and Unloading:
 - 1. Deliver materials and equipment to the Project site in a clean condition with openings plugged or capped (or otherwise sealed by packaging) both during shipping and during temporary storage.
 - 2. Delivered electrical equipment crating and/or packaging shall clearly identify pick-points or lift-points. In the absence of crating or packaging, pick-points or lift-points shall be identified on the equipment.
 - 3. When unloading materials and equipment, provide special lifting harness or apparatus as may be required by manufacturers. Handle materials and equipment in accordance with manufacturer's written instructions.
 - 4. The Contractor shall determine the required equipment needed for unloading operations and have such equipment on site to perform unloading work on the date of equipment delivery.
- B. Storage and Protection: Store materials and equipment, both on and off site, in accordance with manufacturer's written instructions.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Products: Material particulars and requirements as specified in the various Sections included under Division 16 - Electrical.
 - 1. Products applicable to specific Electrical Specifications Sections, or for special applications, are specified in those Sections.
 - 2. Provide Products of new and recent manufacture.
 - 3. For each category of materials and equipment (Products), provide Products of the same manufacturer and type.

- B. Shop Paint: For primer coat use only those primers that are compatible with field coats specified under this Section.

PART 3 EXECUTION

3.01 INSTALLATIONS AND REMOVALS

- A. General Requirements: Installation particulars and requirements are as specified in the various Sections included under Division 16 - Electrical.
 - 1. Perform required interconnection of the differing electrical systems to the various electrical equipment, devices, or apparatus, regardless of where such Products are specified throughout Division 16 - Electrical, in order to ensure the completeness of such electrical system.

- B. Factory Finishes and Field Painting:
 - 1. General Requirements: Painting of the materials, equipment, apparatus, and items installed as work of this Division 16 shall be painted as field painting work of this Division as per requirements of Section 09900.
 - a. The above requirement does not apply to fully factory-finished items, that is, items having factory applied primer and final finish coatings, except as specified in the following paragraphs.
 - b. Painting factory-finished items shall be required in the cases where the factory finish is damaged. Such painting shall be performed as work under this Division 16, and as specified herein.
 - 2. Surface Preparation: This Contractor is responsible for the quality of the repaint work insofar as proper surface preparation shall affect the finished appearance. The quality of the repaint work shall be subject to the Engineer's approval.
 - a. Perform surface preparation of damaged areas in conformance with the latest edition of the Steel Structures Painting Council Standard SSPC-SP2, Hand Tool Cleaning.
 - b. Where a damaged area occurs on one surface of an item having several surfaces, that entire surface where the damage occurs shall require repainting. The surface preparation for outside the damaged area shall consist of a light sanding to profile the existing paint.
 - 3. Paint Application: Apply paint in such a manner so that the finished appearance shall match as nearly as possible the factory finish.
 - a. Use paint material matching the composition of the factory applied products.
 - b. Comply with the paint manufacturer's label instruction for mixing, thinning, proper spreading rate, drying time, and environmental limitations concerning application.

4. Factory Finish:
- a. Factory finish on all exterior electrical equipment such as the medium voltage switchgear and the step-down, pad mounted, dry type distribution transformers shall conform to the following:
 - 1) After fabrication, all welded steel, galvanized parts and welded assemblies shall be thoroughly cleaned and phosphatized to provide a crystalline phosphate coating which shall give an excellent corrosion resistance and superior adhesion of paint finish.
 - 2) All metal enclosing sheets and framework, both inside and outside, shall then be given a priming coat of rust inhibiting paint and a finished coat of Sherwin-Williams, Fawn Color (MC-56, LRV 46 percent) or approved equal; which shall have a high performance protection against atmospheric exposure to chemicals, salt spray, stains, abrasion and moisture.
 - 3) Following paint application, uncured parts shall be baked to produce a hard durable finish. Paint film shall be uniform in color and free from blisters, sags, flaking and peeling. A minimum of two top coats shall be applied and the total thickness of the finish shall be maintained at an average of 2 mils.
 - 4) Adequacy of paint finish to inhibit the buildup of rust on ferrous metal materials shall be tested and evaluated per paragraphs 5.2.8.1-7 of ANSI C37.20.2-1987. Salt spray withstand tests in accordance with paragraph 5.2.8.4 of ANSI C.37.20.2-1987 shall be performed on a periodic basis to insure conformance to this corrosion resistance standard.

END OF SECTION

SECTION 16060

ELECTRICAL GROUNDING AND BONDING

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: The work specified in this Section consists of connecting, energizing, testing, cleaning and protecting grounding and bonding systems.
- B. Related Sections:
 - 1. Basic Electrical Requirements: Section 16010.
 - 2. Electrical Testing: Section 16080.

1.02 REFERENCES

- A. American Society for Testing Materials (ASTM):
 - 1. ASTM B1 Hard-Drawn Copper Wire.
 - 2. ASTM B8 Specification for Concentric Lay Stranded Copper Conductors, Hard Drawn, Medium Hard Drawn, or Soft Drawn.
 - 3. ASTM D5 Test for Penetration of Bituminous Materials.
 - 4. ASTM D149 Dielectric Breakdown Voltage and Dielectric Strength of Electrical Insulating Materials at Commercial Power Frequencies.
 - 5. ASTM D257 Test for Direct Current Resistance or Conductance of Insulating Materials.
 - 6. ASTM D570 Test for Water Absorption of Plastics.
- B. National Fire Protection Association (NFPA):
 - 1. NFPA 70 National Electrical Code (NEC).
- C. National Electrical Manufacturing Association (NEMA):
 - 1. NEMA TC-2 Electrical Plastic Tubing (EPT) and Conduit EPC-40, and EPC-80).
 - 2. NEMA WC-7 Cross Linked Thermo Setting Polyethylene Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
 - 3. NEMA WC-26 Wire and Cable Packaging.

1.03 QUALITY ASSURANCE

- A. Products meeting the requirements of one of the following nationally recognized testing laboratories
 - 1. Listed and labeled by Underwriters Laboratory (UL).
 - 2. Certified as meeting the standards of Underwriters Laboratory by the Electrical Testing Laboratory (ETL).
- B. Conform all work to NFPA 70, National Electrical Code.
- C. Perform work under supervision of skilled licensed electricians.

1.04 DELIVERY, STORAGE AND HANDLING

- A. Package all wire and cable to conform to NEMA WC-26.
- B. Store all products indoors on blocking or pallets.

PART 2 PRODUCTS

2.01 WIRE

- A. Bare Ground Wire:
 - 1. Soft drawn copper, Class A or Class B stranded, meeting the requirements of ASTM B8 for sizes #6 or larger.
 - 2. Soft drawn solid copper, meeting the requirements of ASTM B1 for sizes #8 or smaller.
- B. Insulated Ground Wire:
 - 1. Copper, Class B stranded, 600 volt, type XHHW-2, green in color, insulated, and conforming to NEMA WC-7 for sizes #8 and larger.
 - 2. Solid copper, 600 volt, type XHHW-2, green in color, insulated, and conforming to NEMA WC-7 for sizes #10 and smaller.

2.02 CLAMPS AND CONNECTORS

- A. Bronze or brass:
 - 1. All bolts and other material must be bronze or brass, plated steel screws are unacceptable.
 - 2. Multi-bolt solderless compression clamps:
 - a. High strength electrical bronze with silicon bronze clamping bolts and hardware.
 - b. Bolts, nuts, lock-washers and similar hardware designed not to damage ground wire.

- B. Acceptable Manufacturers:
 - 1. IlSCO.
 - 2. Burndy.
 - 3. Or Approved Equal.

PART 3 EXECUTION

3.01 GROUND WIRE SIZES

- A. The minimum size for bonding jumpers, equipment ground conductors, grounding electrode conductors and ground grid conductors shall be:
 - 1. No smaller than #12 AWG.
 - 2. Sized in accordance with NFPA 70, when ground wire size is not specified or indicated on the Drawings.

- B. Over 600 volts:
 - 1. As indicated on the drawings.

3.02 INSTALLATION OF EQUIPMENT GROUND WIRES

- A. General:
 - 1. Connect all of the equipment ground wires and conduit bond wires within a box or an enclosure to a single ground stud or a single common ground bus.
 - 2. Where more than 4 conduits enter a box or enclosure, provide an equipment ground bus.
 - 3. Size ground bus to 100 percent of the rating or setting of the largest over current device in the circuit(s) ahead of equipment, conduit or other item and as indicated on the Drawings.
 - 4. Ground systems and connections mechanically secure and electrically continuous.
 - 5. Connect service entrance grounds direct to the ground grids without splices in the cable.
 - 6. When more pieces of equipment other than service grounds require external bond wires in an area, provide an equipment ground bus.

- B. Bond each run of raceways to form a continuous path for ground faults from end to end. When liquid tight flexible metal conduit of sizes larger than 1-inch or flexible metal conduit is installed, provide external bond wires.
- C. Insulated, internal equipment ground wire in all conduits. Bond the internal wire to all pullboxes, junction boxes, equipment enclosures, and other enclosures as required by NFPA 70.
- D. All 1-inch or larger metallic conduits shall have grounding bushings unless they enter metallic enclosures in integral threaded hubs. All conduits shall have grounding bushings entering the bottom of freestanding equipment. All conduit runs shall have two locknuts unless they enter metallic enclosure in integral threaded hubs. Bond wire from every grounding bushing to the equipment ground stud or ground bus in the enclosure. Bond grounding bushings to ground studs or ground buses in enclosures.

- E. Motors:
 - 1. Install equipment grounding wire within conduit supplying motor.
 - 2. Install bonding connectors across the liquid tight flexible conduit supplying the motors.
- F. Metallic Piping Systems:
 - 1. Bond metallic piping systems as indicated on the Drawings.
- G. Access Floor System:
 - 1. Bond access floor system as indicated on the Drawings.

3.03 FIELD QUALITY CONTROL

- A. Site Testing - Prior to Energizing Any System:
 - 1. Test the resistance to ground for the system in accordance with Section 16080.
- B. Inspection: Inspect all items for conformity to the drawings and specifications prior to completion.

3.04 PROTECTION

- A. Protect finished insulated wires from painting.

END OF SECTION

SECTION 16070

ELECTRICAL HANGERS AND SUPPORTS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: The work specified in this Section consists of material for furnishing, installing, cleaning and protecting hanger and support systems for electrical wiring, conduit boxes, and equipment.
- B. Related Section:
 - 1. Basic Electrical Requirements: Section 16010.

1.02 REFERENCES

- A. American Society for Testing Materials (ASTM)
 - 1. ASTM A36 Specification for structural steel.
 - 2. ASTM A53 Specification for pipe, steel, and hot-dipped, zinc-coated, welded and seamless.
 - 3. ASTM A153 Specification for zinc coating (hot-dip) on iron and steel hardware.
 - 4. ASTM A283 Specification for Mild Steel Plates.
 - 5. ASTM A325 Specification for carbon steel externally threaded standard fasteners.
 - 6. ASTM A500 Specification for cold-formed welded and seamless carbon steel structural steel tubing in rounds and shapes.
 - 7. ASTM A525 Specification for plain-end and seamless pipe.
 - 8. ASTM A563 Specification for carbon and alloy steel nuts.
 - 9. ASTM A570 Specification for steel, sheet and strip, carbon, hot-rolled, structural quality.
 - 10. ASTM A575 Specification for steel bars, carbon, merchant quality, hot wrought.
 - 11. ASTM A576 Specification for steel bars, carbon, structural quality, hot wrought.
 - 12. ASTM A633 Specification for normalized, high-strength, low-alloy structural steel plates.
 - 13. ASTM A635 Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Carbon, Hot-Rolled
 - 14. ASTM E84 Specification for fire resistance of building materials.
- B. Federal Specifications:
 - 1. Fed. Spec. FF-S-107C(2) Screws, tapping and drive
 - 2. Fed. Spec. FF-S-325 Shield, expansion nail, & drive screw Group II, Type 4, Class 1

- C. National Fire Protection Association (NFPA):
 - 1. NFPA 258 Method for Determining Smoke Generation of Solid Materials
- D. American Welding Society:
 - 1. AWS D1.1 Structural Welding Code-Steel
- E. Society of Automotive Engineers
- F. American Iron and Steel Institute
- G. Steel Structures Painting Council (SPCC):
 - 1. SSPC-2 Hand Tool Cleaning

1.03 QUALITY ASSURANCE

- A. Provide products that are listed and labeled by Underwriters Laboratory, approved by Factory Mutual, or certified as meeting the standards of UL by the Electrical Testing Laboratory (ETL) unless products meeting the requirements of these testing laboratories are not readily available or unless standards do not exist for the products.
- B. Select manufacturer of support framing that has been manufacturing support framing for a minimum of 5 years.
- C. Provide manufacturers certification that the galvanizing and the products meet the ASTM standards specified.

1.04 DELIVERY, STORAGE AND HANDLING

- A. Deliver material to job site in the original factory packaging.
- B. Store the components under shelter and undercover supported off the ground and floors on blocking.

PART 2 PRODUCTS

2.01 MATERIALS - STEEL

- A. Provide steel shapes in sizes as indicated and as follows:
 - 1. Steel Sections: ASTM A36/A, A36M
 - 2. Steel Tubing: ASTM A500, Grade B
 - 3. Plates: ASTM A283
 - 4. Sheets: ASTM A570
 - 5. Pipe: ASTM A53, Grade B Schedule 40, hot-dipped, zinc-coated

2.02 U-CHANNEL SUPPORT FRAMING SYSTEMS

- A. Acceptable Manufacturers:
 - 1. Provide products of a single manufacturer for metal framing systems and fittings for metal framing systems. Acceptable manufacturers are:
 - a. Unistrut.
 - b. Kindorf.
 - c. B-Line.
 - d. Or Approved Equal.
- B. For noncorrosive locations:
 - 1. Provide U-channel supports, 1-5/8-inch (41mm) nominal, fabricated from minimum 14 gauge ASTM A570, grade 33 structural and electrolytically zinc-coated to conform to ASTM B633, Type II, SC1. Provide combination members where required that are spot-welded on 3-inch centers. Provide depths of 1-3/8-inch (35mm) or larger, however, when supports are mounted directly to walls provide depths of 13/16-inch (21mm) or larger.
 - 2. Conforming to ASTM A575, A576, A635, or A36 with electro-galvanized finish conforming to ASTM B633, Type III, SC1.

2.03 NONMETALLIC SUPPORTS

- A. Provide non-metallic angles, channels and bars fabricated from high impact strength, fiberglass reinforced polyester formulation having glass to resin ratio of 45 to 55 percent by weight. The angles, channels and bars shall meet or exceed a Class 1 flame spread rating of less than 25 (ASTM E84) and a smoke rating of 5 (NFPA 258 Smoke Chamber Test).
 - 1. Acceptable Manufacturers:
 - a. JBC Enterprises (Enduro).
 - b. Robroy Industries.
 - c. Or Approved Equal.
- B. Pre-engineered UL listed supporting systems of glass-fiber-reinforced composites may be used in lieu of field fabricated support systems.
 - 1. Acceptable Manufacturers:
 - a. Unistrut.
 - b. Aickinstrut.
 - c. JBC Enterprises (Enduro).
 - d. Or Approved Equal

2.04 CONDUIT SUPPORTS

- A. Provide one-hole style fastener of malleable iron for exterior use and of stamped steel for interior use. Provide both types in galvanized finish. Provide pipe straps manufactured by Thomas & Betts or approved equal.

2.05 CABLE SUPPORTS

- A. Panelboards/Enclosures: Furnish and install cable supports in feeder risers as required by the underwriters. Provide supports of hot dipped galvanized malleable iron with a threaded collar and furnished with a hard fiber, impregnated hardwood or a canvas bakelite tapered wedging cable plug. Provide voltage rated supports as manufactured by the O. Z. Electrical Manufacturing Co., Inc., Type "M" or approved equal.

2.06 ANCHORS AND FASTENERS

- A. Drive (Deep-Pitch) Screws: Self-tapping type, galvanized steel, Fed. Spec. FF-S-107C(2).
- B. Drilled-In Anchors and Fasteners: Fed. Spec. FF-S-107C(2).
 - 1. Applications in Masonry:
 - a. Anchors: Provide anchors designed to accept both machine bolts and threaded rods. Provide anchors consisting of an expansion shield and expander nut contained inside the shield. Provide expander nut fabricated and designed to climb the bolt or rod thread and simultaneously expand the shield as soon as the threaded item, while being tightened, reaches and bears against the shield bottom.
 - b. Shield Body: Provide shield body consisting of four legs, the inside of each tapered toward shield bottom (or not end). The end of one leg shall be elongated and turned across shield bottom. Outer surface of shield body shall be ribbed for grip-action.
 - 2. Expander Nut: Provide square design with sides tapered inward from bottom to top.
 - 3. Material: Provide die cast Zamac No. 3 zinc alloy of 43,000 psi (297mPa) minimum tensile strength.
 - 4. Fasteners: Provide galvanized steel machine bolts conforming to S.A.E. Grade 2 for use with above anchors; nuts and washers to conform to ASTM A 563.
 - 5. Acceptable Manufacturers:
 - a. U.S.E. Diamond, Inc.; FORWAY System.
 - b. Or Approved Equal.
 - 6. Applications in Cast-in-Place Concrete:
 - a. Anchor/Fastener: Provide UL listed and one-piece stud (bolt) with integral expansion wedges, nut and washer, and meeting physical requirements of Fed. Spec. FF-S-325, Group II, Type 4, Class 1.
 - b. Galvanized Steel Anchor/Fastener: Provide one-piece stud (bolt) with integral expansion wedges, nut and washer, and meeting physical requirements of Fed. Spec. FF-S-325, Group II, Type 4, Class 1. Stud, nut and washer of galvanized steel.
 - c. Acceptable Manufacturers:
 - 1) U.S.E. Diamond, Inc.; SUP-R-STUD.
 - 2) Hilti Fastening Systems; KWIK-BOLT.
 - 3) Molly Fastener Group; PARABOLT.
 - 4) Phillips; RED HEAD Wedge-Anchor.
 - 5) Or Approved Equal

- C. Note: Hammer drive-type explosive charge drive-type anchors and fastener systems are not acceptable. Lead shields, plastic-inserts, fiber-inserts, and drilled-in plastic sleeve/nail drive systems also not acceptable.

2.07 WALL SEAL

- A. Provide hydrostatic seal to seal opening between conduit and a through structure opening; provide Link-Seal by Thunderline Corp. or approved equal.

2.08 ACCESSORIES

- A. Provide bolts, nuts, and washers smaller than 1/4-inch (7mm) trade size galvanized steel; ASTM A 325 galvanized to ASTM A 153/A 153M.
- B. Welding materials: AWS D1.1; type required for materials being welded.
- C. Touch-up primer: SSPC-Paint 15, Type 1, red oxide.
- D. Touch-up primer for galvanized surfaces: SSPC-Paint 20, Type I, inorganic zinc.

PART 3 EXECUTION

3.01 PREPARATION

- A. Inspect the structural and finish condition as well as other construction work which may affect the work of this Section.
- B. Modify electrical work to conform to existing conditions and other work.

3.02 INSTALLATION

- A. Anchor And Fastener Installations:
 - 1. Threaded Bolts: Draw threaded bolted connections up tight using galvanized steel lock washers to prevent bolt or nut loosening.
 - 2. Drilled-In Expansion Anchor Installation:
 - a. General: Install expansion anchors in strict accordance with manufacturer's instructions and in accordance with the following.
 - b. Drilling Holes: Make drill holes to the required diameter and depth in accordance with anchor manufacturer's instructions for size of anchors being installed.
 - c. Minimum Embedment: Embed expansion anchors to four and one-half bolt diameters unless otherwise indicated on drawings.

3.03 FABRICATION

- A. Fit and shop assemble items in largest practical Sections for delivery to site.

- B. Fabricate items with joints tightly fitted and secured.
- C. Continuously seal joined members by intermittent welds and plastic filler.
- D. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline.
- E. Ease exposed edges to small uniform radius. Cut all backboard corners to 1-inch radius.
- F. Exposed mechanical fastenings: Provide flush countersunk screws or bolts; unobtrusively located, consistent with design of component except where specifically noted otherwise.
- G. Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication except where specifically noted otherwise.
- H. Drill or punch holes accurately as required for attachment of work and for bolted connections. Burned holes are not acceptable. Holes shall be no more than 3/32-inch larger than fasteners.
- I. Perform welding of assemblies in accordance with AWS D1.1. Dress welds smooth and free of sharp edges and corners.
- J. Fabrication Tolerances:
 - 1. Squareness: 1/8 inch (3 mm), maximum difference in diagonal measurements.
 - 2. Maximum offset between faces: 1/16 inch (1.5 mm).
 - 3. Maximum misalignment of adjacent members: 1/16 inch (1.5 mm).
 - 4. Maximum bow: 1/8 inch (3 mm) in 48 inches (1.2 m).
 - 5. Maximum deviation from plane: 1/16 inch (1.5 mm) in 48 inches (1.2 m).
- K. Fabricated Items:
 - 1. Backboards, backboard supports, equipment supports, conduit supports, and the other items: hot-dip galvanize the mild-steel fabrications conforming to ASTM A153.

3.04 FINISHES-STEEL

- A. Prime paint the non-galvanized steel items.
 - 1. Prepare surfaces to be primed in accordance with SSPC-SP2.
 - 2. Clean surfaces of rust, scale, grease, and foreign matter prior to finishing.
 - 3. Prime Painting: One coat.
- B. Galvanizing of items specified above as galvanized: Galvanize after fabrication to ASTM A 123. Provide minimum 1.25 oz/sq ft (380 g/sq m) galvanized coating.

3.05 FIELD QUALITY CONTROL

- A. Inspect the items for the following and correct any discrepancies:
 - 1. Adequacy of coating, damage to coatings. Touch up damaged coating surfaces; use specified primer for primed steel surfaces, use zinc-rich primer for galvanized steel surfaces.
 - 2. Adherence to fabrication tolerances:
 - a. Squareness: 1/8 inch (3 mm), maximum difference in diagonal measurements.
 - b. Maximum offset between faces: 1/16 inch (1.5 mm).
 - c. Maximum misalignment of adjacent members: 1/16 inch (1.5 mm).
 - d. Maximum bow: 1/8 inch (3 mm) in 48 inches (1.2 m).
 - e. Maximum deviation from plane: 1/16 inch (1.5 mm) in 48 inches (1.2 m).

3.06 PROTECTION

- A. Protect the items during work of other trades.

END OF SECTION

SECTION 16075

ELECTRICAL IDENTIFICATION

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: The work specified in this Section consists of material for furnishing, installing, cleaning and protecting identification signs and labels for electrical systems.
- B. Related Section:
 - 1. Basic Electrical Requirements: Section 16010.
 - 2. Low Voltage Wire, Cable and Accessories: Section 16122

1.02 SUBMITTALS

- A. Product Data and Catalog Cuts:
 - 1. Provide product data for all products provided. Indicate clearly the usage of each product.
- B. Shop Drawings: Submit shop drawings for the following items:
 - 1. Schedule depicting all name-tag legends.
 - 2. Drawing of typical nametags.

PART 2 PRODUCTS

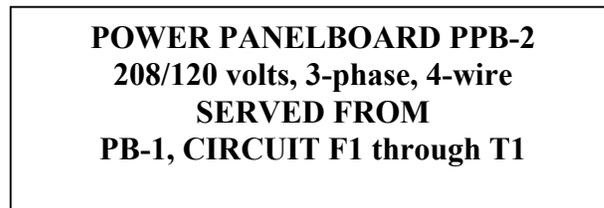
2.01 IDENTIFICATION

- A. Provide nameplates as specified below for the following electrical equipment:
 - 1. Enclosed Circuit Breakers Section 16411
 - 2. Enclosed Disconnect Switches Section 16413
 - 3. Low-Voltage Variable Frequency Drives Section 16425
 - 4. AC Panelboards Section 16443
 - 5. Power Conditioning Units Section 16462

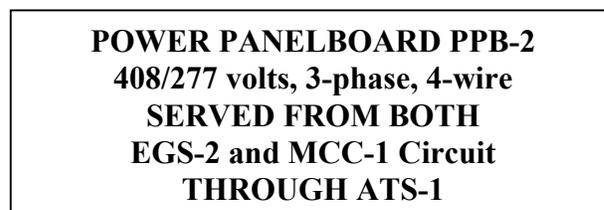
B. Identification Nameplates

1. Provide information as follows on each nameplate:
 - a. First Line - Equipment type and identification number.
 - b. Second line - Voltage, current, phase, number wires.
 - c. Third line - The words "SUPPLIED FROM" followed by the serving equipment and the branch circuit. If multiple sources, list all sources on succeeding lines.
 - d. For motor starters, circuit breakers, transformers and disconnects provide an additional line - The words "SERVES" and the equipment served.
 - e. If supplied through automatic transfer switches and transformers or other items without disconnects, include data on all upstream disconnects and beneath the sources add the word "through" followed by the name of the equipment that the sources are connected through.
2. Use 3/8-inch (10mm) letter for line 1, and 1/4-inch (6mm) letters for the succeeding lines except for small equipment where the tag will not fit. Use 3/16-inch (3mm) letters for the top line and 1/8-inch letters for the succeeding lines. Use white letters on a black background.

EXAMPLE 1:



EXAMPLE 2:



- C. Identify each wiring device (switches, receptables), outlet box, pull box, junction box, equipment cabinet and point of use not otherwise identified with the source of power (for example, panelboard and circuit number.) Provide this data on a laminated phenolic tag above or next to the box. Use 1/8-inch (3mm) white letters on a black background.
- D. Identify wiring in conformance with Sections 16122 and 16300.

PART 3 EXECUTION

3.01 INSTALLATION

- A.  All nameplates in the top center of front face of equipment in a visible location using 316 stainless steel screws, Seton Adhesive #15660, or approved equal.
- B.  All nameplates for above ground wiring device boxes, outlets boxes, pull boxes and junction boxes adjacent or above item in visible location using 316 stainless steel screws, Seton Adhesive #15660, or approved equal.
- C.  All nameplates for in-ground pull boxes and junction boxes adjacent or above item in visible location inside the box immediately below the cover using 316 stainless steel screws, Seton Adhesive #15660, or approved equal.

3.02 FIELD QUALITY CONTROL

- A. Verify data on each name tag.

END OF SECTION

SECTION 16080

ELECTRICAL TESTING

PART 1 GENERAL

A. SUMMARY

B. Section Includes: The work specified in this Section consists of materials to performance test electrical systems and equipment.

1. Items Supplied Under This Section:

- a. Electrical System Testing
- b. Ground System Testing
- c. Insulation Testing
- d. Equipment Testing
- e. Performance Test
- f. Test Procedure
- g. Test Report

C. Related Sections:

1. Basic Electrical Requirements: Section 16010.
2. Wiring Devices: Section 16141.

1.02 REFERENCES

A. National Fire Protection Association (NFPA):

1. NFPA 70 National Electrical Code (NEC).
2. NFPA 70E

B. National Electrical Testing Association:

1. ATS-1 Acceptance Testing.

1.03 SUBMITTALS

A. 60 days prior to any testing:

1. Submit qualifications of testing laboratory and technicians supervising testing.
2. Provide evidence of calibration of all test equipment to be used.
3. Test Procedure.
4. Submit data on all test equipment including evidence of traceability to National Standards.

B. Submit test report covering all testing.

1.04 QUALITY ASSURANCE

- A. Qualifications of Testing Laboratory: Select an independent nationally recognized testing laboratory that is independent from electrical contractor that either is a member of The International Electrical Testing Association or meets the following qualifications:
 - 1. Is nationally recognized as an electrical testing laboratory.
 - 2. Has been regularly engaged in the testing of electrical systems and equipment for at least 5 years.
 - 3. Is independent from the electrical contractor, the ROICC, the Engineer and all other contractors on the job.
 - 4. Has at least one Professional Engineer on staff that is licensed in the District of Columbia.
 - 5. Derives more than 80 percent of its income from electrical testing.
 - 6. Owns or leases sufficient calibrated equipment to do the testing required.
 - 7. Has a means to trace all test instrument calibration to The National Bureau of Standards.
- B. Membership in the International Electrical Testing Association (NETA) shall be considered evidence of meeting items A. 1. through and including A. 5.
- C. Testing shall be done under the supervision of a technician certified by International Electrical Testing Association or by technicians that are both certified by the National Society of Professional Engineers and experienced in electrical testing with 5 years of testing experience.
- D. The testing laboratory shall supervise or perform all testing of equipment and oversee setting of all circuit breakers and calibration of all instruments.

1.05 SCHEDULING

- A. Schedule all testing with work of other contractors to ensure an orderly sequence of startup and completion of work.

PART 2 PRODUCTS NOT USED

PART 3 EXECUTION

3.01 ELECTRICAL INSPECTIONS AND TESTS

- A. Perform, supervise, and furnish all test equipment needed to perform tests and provide safety measures, procedures and equipment required for each test.

- B. Schedule all testing with the Engineer. Perform testing in the presence of the the Engineer except when the Engineer approves in writing conducting a specific test without the Engineer's presence.
- C. Notify all involved parties including the Engineer prior to tests, advising them of the test to be performed and the scheduled date and time.
- D. Coordinate the tests with others involved.
- E. Prepare written test procedures and forms used in the test reports and submit for approval prior to commencement of testing.
- F. Include in each test report the following information:
 - 1. Job title.
 - 2. Date of test.
 - 3. Equipment, system or cable identification.
 - 4. Type of test.
 - 5. Description of test instrument and date of latest calibration.
 - 6. Section of specification defining test along with description of test and evaluations as reported by the testing company.
 - 7. Test results (correct all readings at 20 degrees C).
 - 8. Signature of person supervising test.
 - 9. Signature of Contractor.

3.02 TESTING TO BE PERFORMED BY THE CONTRACTOR

- A. Wire and Cable:
 - 1. Test all wires and cables sized No. 2 and larger in accordance with NETA ATS 1, paragraph 7.3.1.1 and 7.3.1.2.
 - 2. Perform visual, mechanical, and electrical tests on all No. 4 and No. 6 power cables that operate at voltages exceeding 150 volts to ground in accordance with NETA ATS 1, paragraph 7.3.1.1 and 7.3.1.2.
 - 3. Perform visual, mechanical, and electrical tests on all other wires and cables in accordance with NETA ATS 1, paragraph 7.3.1.1.
 - 4. Replace any wires which have been damaged.
 - 5. Correct causes of all readings which do not meet the acceptable minimum insulation readings are as stated in NETA ATS 1, paragraph 7.3.1.3. Exceed the nominal expected temperatures for the actual load.
 - 6. Retest items requiring correction.
- B. Transient Voltage Surge Suppressors (TVSS):
 - 1. Visually and mechanically inspect the TVSS unit and connections.
 - 2. Use an AC voltmeter to check all voltages and ensure that normal operating voltages of the power system match the voltage rating on the TVSS nameplate.
 - 3. Check LED status indicators on the display panels and suppression modules to confirm normal status.

4. Press the alarm test button to confirm the audible alarm and LED.
 5. Operate the alarm silence switch to confirm proper operation.
- C. Ground Fault Circuit Interrupter (GFCI) Receptacles:
1. Test all GFCI receptacles as specified in Section 16141.

3.03 TESTING TO BE PERFORMED BY THE TESTING LABORATORY

- A. Select, hire and pay an independent nationally recognized electrical testing laboratory to perform all testing specified in this article. Obtain ROICC's approval of the testing laboratory and the testing laboratory proposed test procedure prior to commencement of any tests.
- B. Low Voltage Molded Case Circuit Breaker Tests:
1. Visually and mechanically inspect and electrically test all low voltage circuit breakers in frame sizes rated 100-amperes or more in accordance with NETA ATS 1, paragraph 7.6.1.1.1 and NETA ATS 1, paragraph 7.6.1.1.2.
 2. Acceptable values are as stated in NETA ATS 1, paragraph 7.6.1.1.3.
- C. AC Motor Testing:
1. Visually and mechanically inspect and electrically test all AC motors rated 10-horsepower or more in accordance with NETA ATS 1, paragraph 7.15.1.1 and NETA ATS 1, paragraph 7.15.1.2.
 2. Acceptable test values are as stated in NETA ATS 1, paragraph 7.15.1.4.
 3. Immediately report all motors which fail inspection to the Engineer for correction.
- D. Low Voltage Motor Starter Tests:
1. Visually and mechanically inspect and electrically test all low voltage motor starters rated 10-horsepower or more in accordance with NETA ATS 1, paragraph 7.16.1.1.1 and NETA ATS 1, paragraph 7.16.1.1.2.
 2. Acceptable values are as stated in NETA ATS 1, paragraph 7.16.1.1.3.
- E. Voltage Adjustment:
1. Measure the plant voltage with the plant operated at both no load and at nominal load at the following locations.
 - a. Main Distribution Switchboard.
 - b. Each panelboard bus.
 2. Adjust all transformer taps to bring the no-load voltage above nominal, but in no case, higher than 105.8% of nominal. Adjust the operated loaded voltage to a value above 91.7%, (ANSI Range A), with only momentary excursions to a maximum of 105.8% and a minimum of 88.3% for all loads and 86.7% for motor loads. (ANSI Range B).
 3. After all adjustments have been made, remeasure all voltages.
 4. For record purposes measure and record on all 3-phases, actual plant load at all switchboard and panelboard buses.

5. With a minimum/maximum recording voltmeter measure starting voltage dip for the largest motor at:
 - a. Starter terminals.
 - b. Panelboard.
 - c. Main Distribution Switchboard.
6. Measure minimum/maximum/average voltage at Main Distribution Switchboard over a 24 hour period with the plant running on at least one phase with recording voltmeter.

F. Harmonic Testing

1. Conduct harmonic testing at:
 - a. Main Distribution Switchboard.
 - b. Points of Common Coupling (PCC). PCC defined as nearest switchboard or panelboard which directly serves each variable frequency drive.
 - c. Generator terminals.
 - d. Transformer primary terminals.
2. Measure and record the following data at each location where harmonic testing is required:
 - a. Current Distortion: Total harmonic distortion (THD) and individual harmonic components up to and including the 35th harmonic.
 - b. Voltage Distortion: Total harmonic distortion (THD) and individual harmonic components up to and including the 35th harmonic.
 - c. Voltage Notching: Notch area (volt-microseconds) and depth (volts).
 - d. For record purposes measure and record on all 3-phases, actual plant load at all switchboard and panelboard buses.
3. Conduct harmonic testing with harmonic producing loads in operation. Record the following information for variable frequency drives, taken at the time harmonic distortion measurements are made:
 - a. Output frequency.
 - b. Output current.
 - c. Output voltage.
 - d. Output power factor when motor metering includes this capability.
4. Conduct harmonic testing with variable frequency drives operating at full load and half load.
5. Test report shall include the following calculated values at each location where harmonic testing is required:
 - a. Total demand distortion (TDD).
 - b. Individual harmonic current distortion in percent of the maximum demand load current up to and including the 35th harmonic.

G. Power Conditioning Units Testing:

1. Visually and mechanically inspect the power conditioning unit and connections.
2. Tests and measurements shall be made at the panelboard immediately downstream from the power conditioning unit. Voltages shall be measured and recorded for all three phases.
3. Tests:

- a. Steady state voltage regulation for steady state loads varying from no load to full load. Acceptable test result: +/- 1.0%.
 - b. Step voltage regulation for 25% step load, 50% step load and 100% step load. Acceptable test result: +/- 5.0%, +/- 8.0% and +10/-8%, respectively.
 - c. Step load recovery time to +/- 1.0% voltage with up to 100% step. Acceptable test result: Within 1 cycle.
 - d. Voltage distortion: Total harmonic distortion (THD) and individual harmonic components up to and including the 35th harmonic. Acceptable test result: 5.0% total harmonic distortion, 3% any single frequency.
 - e. Phase angle with up to 30% unbalanced load. Acceptable test result: +/- 3.0%.
4. For record purposes measure and record on all 3-phases, actual voltage and voltage distortion (total harmonic distortion and individual harmonic components up to and including the 35th harmonic) at the input to the power conditioning unit.

3.04 TESTING TO BE PERFORMED BY MANUFACTURER'S REPRESENTATIVE

A. AC Variable Frequency Drive (VFD) Tests:

1. On completion of the installation, the initial start-up shall be performed by a factory-trained representative of the AC drive manufacturer. Two copies of operating and maintenance instruction books shall be supplied for the test of the AC drives.
2. Provide equipment manufacturer's certification that the AC drives are installed, inspected, tested, adjusted and approved satisfactory by equipment manufacturer's service engineer.
3. Instruct ROICC's personnel regarding equipment operation and maintenance procedures.
4. Furnish copies of complete lists of spare parts and special tools recommended for 2 years of normal operation of the complete system including the manufacturer's name, addresses, catalog numbers and prices.

B. Power Correction Systems (Active Harmonic Filters) Tests:

1. On completion of the installation, the initial start-up shall be performed by a factory-trained representative of the Power Correction System manufacturer. Two copies of operating and maintenance instruction books shall be supplied for the test of the Power Correction Systems.
2. Provide equipment manufacturer's certification that the Power Correction Systems are installed, inspected, tested, adjusted and approved satisfactory by equipment manufacturer's service engineer.
3. Instruct ROICC's personnel regarding equipment operation and maintenance procedures.
4. Furnish copies of complete lists of spare parts and special tools recommended for 2 years of normal operation of the complete system including the manufacturer's name, addresses, catalog numbers and prices.

3.05 CORRECTION OF DEFICIENCIES

- A. Report all unacceptable values immediately. Correct all deficiencies found in work of this contract and separately report deficiencies in work of items of other contracts.
 - 1. Retest items requiring correction. Correct or have corrected any remaining deficiencies and retest until work is acceptable.

END OF SECTION

SECTION 16110

METALLIC RACEWAY SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: The work specified in this Section consists of constructing the metallic raceway systems for the project.
- B. Related Sections:
 - 1. Basic Electrical Requirements: Section 16010.
 - 2. Electrical Hangers and Supports: Section 16070.

1.02 REFERENCES

- A. Federal Specifications:
 - 1. Fed. Spec. WW-C-563A, Conduit Metal, Rigid Electrical, Thin-Wall Steel Type (E.M.T.) Straight Lengths, Elbows, and Bends.
 - 2. Fed. Spec. WW-C-566B, Conduit, Metal, Flexible.
 - 3. Fed. Spec. WW-C-581D, Conduit, Metal, Rigid and Coupling Elbow, and Nipple, Electrical Conduit, Zinc-Coated.
 - 4. Fed. Spec. WW-C-581E, Conduit, Metal, Rigid, and Intermediates; and Coupling, Elbow, and Nipple, Electrical Conduit: Steel Zinc Coated.
 - 5. Fed. Spec W-C-582, Conduit, Raceway, Metal, and Fittings, Surface.
 - 6. Fed. Spec. W-C-586B, Conduit Outlets and Entrance Caps, Electrical Cast Metal-For Shore Use.

1.03 SUBMITTALS

- A. Product Data: Submit manufacturer's catalog cuts for the following materials:
 - 1. Surface metal raceway.

1.04 QUALITY ASSURANCE

- A. Product Quality Control:
 - 1. Manufacturers shall fabricate their products in such a manner that all criteria for appearance, fit and tolerances shall be complied with.
 - 2. Each manufacturer shall carefully control his operations to ensure that the engineering, quality, safety and reliability of product are achieved.

PART 2 PRODUCTS

2.01 CONDUIT SYSTEM MATERIALS

- A. Rigid Metal Conduits:
1. Fabricated of mild steel piping, galvanized or sherardized inside and outside, and protected against corrosion by a dichromate rinse or a zinc chromate coating. Each conduit shall bear the UL label, be defect free, furnished in 10 foot lengths minimum, threaded both ends, one end fitted with a coupling, and of the following types:
 - a. Rigid Galvanized Steel Conduit and Fittings: Product meeting requirements of NEC Article 346 for materials and uses, and Fed. Spec. WW-C-581D.
 - b. Electrical Metallic Tubing (EMT) and Fittings: Products meeting requirements of NEC Article 348 for materials and uses, and Fed. Spec WW-C-563A.
 - c. Acceptable Manufacturers:
 - 1) Allied Tube and Conduit.
 - 2) Wheatland.
 - 3) Or Approved Equal.
- B. PVC Coated Flexible Metal Conduit: Conduit meeting the requirements of NEC Article 351 for materials and uses, and Fed. Spec. WWC-566B. Each conduit length shall bear manufacturer's trademark and shall conform to the following:
1. Flexible, galvanized, interlocking spiral strip steel core having a smooth, liquid-tight polyvinyl chloride jacket designed to withstand temperatures from minus 40 degrees C. to plus 60 degrees C.
 2. Interlocking spiral strip construction of such to permit bending of conduit to a minimum radius of five times its diameter without deforming the spiral strips both inside and outside of the conduit.
 3. Interior and exterior of flexible conduit finished smooth and free from burrs, sharp edges and other defects which may injure wires.
 4. Conduit sizes 1/2-inch (13mm) through 1-1/4-inch (32mm) furnished with an integral continuous copper ground. Install flexible conduit sizes 1-1/2-inch (38mm) through 4-inch (101mm) using a separate ground conductor.
 5. Acceptable Manufacturers:
 - a. Electri-flex Company, Licutite, Type LA.
 - b. Anaconda American Brass Company, Sealtite, Type D.C.
 - c. Or Approved Equal.
- C. Conduit Bodies/Fittings: Conduit fittings and outlet bodies shall be constructed of cast type materials suitable for use in the raceway system being provided. Material shall be similar to "Feraloy" as manufactured by Crouse Hinds, or approved equal or malleable iron as manufactured by Appleton and O. Z. Gedney, or approved equal. Materials included under this provision include, but not limited to, the following:
1. Conduit Outlet Bodies:
 - a. Form 7 or 9 threaded rigid bodies.
 - b. Type LBD - 90 degree bends for service feeder conduits as required.
 - c. Acceptable Manufacturers:
 - 1) Crouse-Hinds.
 - 2) Appleton.

- 3) Or Approved Equal.
2. Conduit Expansion Joints: Telescoping sleeve type designed for 4 inch maximum expansion; galvanized, weatherproof, vaportight, with insulated bushing and lead-wool packing.
 - a. Acceptable Manufacturers:
 - 1) Crouse-Hinds, Type XJ, with ground strap GC100, and brass clamps GC102.
 - 2) Appleton.
 - 3) Or Approved Equal.
3. Conduit Unions: Erickson Couplings where necessary to complete a conduit run when neither end can be turned.
 - a. Acceptable Manufacturers:
 - 1) Thomas and Betts Company.
 - 2) Appleton.
 - 3) Or Approved Equal.

- D. Metallic Outlet, Switch, Junction, and Fittings: Provide such products meeting requirements of NEC Article 370 for materials and uses in conduit systems, and Fed. Spec. W-J-800C. No indented type couplings or connectors permitted on this project.
1. Fittings and boxes to be stamped steel (concrete tight where required) type construction. Fittings and boxes provided with stamped steel covers and rings for devices and wall finish. Use NEMA Type 4 construction outlet boxes for outdoor and below grade installations.

2.02 SURFACE METAL RACEWAY

- A. Provide surface metal raceway systems conforming to U.S.A. Standards Institute standard as an assembly of corrosion resistant backing and capping, both having an abrasion free interior finish. All necessary and required fittings, accessories and appurtenances shall be provided to form a complete system as indicated on the Drawings. Additionally surface raceway shall comply with NEC Article 352 for materials and uses, and Fed. Spec. W-C-582.
1. Acceptable Manufacturers:
 - a. The Wiremold Company - G6000 Series.
 - b. Or Approved Equal.

2.03 WIREWAY SYSTEM MATERIALS

- A. Wireway (General Purpose, NEMA Type 1): Lengths, connectors and fittings UL Listed and constructed in accordance with Underwriters Laboratories Standard UL 870 for Wireways, Auxiliary Gutters and Associated Fittings.
1. Screw cover design. Covers held firmly in place with captivated screw fasteners.
 2. Wireway constructed without knockouts.
 3. 16 gauge galvaneal sheet metal parts provided with corrosion resistant phosphate primer and ASA-49 gray enamel finish.
 4. Acceptable Manufacturers:

- a. Square D Company (Lay-In Wireway).
- b. Hoffman Engineering Company.
- c. Wiegmann.
- d. Or Approved Equal.

PART 3 EXECUTION

3.01 INSPECTION

- A. Carefully investigate the structural and finish condition, as well as other construction work which may affect the work of this Section. Arrange Electrical Work accordingly and furnish such fittings and apparatus as required to accommodate such conditions and to preserve access to other equipment, rooms, areas, etc.
- B. Prior to performance of work described above, make detailed drawings of proposed departures from original design due to field conditions or other cause, and submit for Engineer's approval.
- C. Inspect installed conduit and remove obstructions, dirt and debris if present.

3.02 PREPARATION

- A. Field Measurement: The Drawings are generally indicative of the work, but due to their small scale, it is not possible to indicate all offsets, fittings, and apparatus required nor the minor structural obstructions that may be encountered.
- B. Obtain roughing-in dimensions of electrically operated equipment being installed in other construction work. Set conduit and boxes only after receiving approved dimensions and checking such equipment locations.
- C. Layout electrical work to suit actual field measurements and according to accepted Trade standard practice. However, electrical installations shall conform to NEC 300 for wiring methods general requirements, and to all other applicable Articles of the NEC governing methods of wiring.

3.03 INSTALLATION

- A. Methods of Wiring: In general fabricate conduit and raceway systems in accordance with accepted Trade standard practice. The following installation requirements are in addition to requirements set forth in Article 300 of the NEC and are included to complement same.
 - 1. Do not attach conduit or raceway systems to suspended ceiling members or to the suspending mediums.

2. Cut conduits and raceways square and deburr cuts to the same degree as cuts made by the material manufacturer. Ream cuts of conduits per NEC requirements with openings not restricted more than cuts made by the material manufacturer.
 3. No conduit smaller than 3/4-inch (19mm) trade size permitted, unless indicated otherwise. No running threads permitted; use approved threaded couplings and connectors for metal conduits where such are required.
 4. Avoid bending conduits as much as possible and practical, but when same are made use an approved conduit bending tool or machine. Do not install crushed or deformed conduit, and remove same from the site. Use flexible conduit only to the extent permitted by NEC.
 5. Mount or suspend conduit and raceway systems directly on structural members of the structures, except where indicated as being wall mounted. Space supports in accordance with NEC requirements.
 6. Attach wall mounted conduit and raceway runs tight to walls, following contour of walls and securely attach anchors into walls.
 7. Do not weaken the structure by excessive or unnecessary cutting.
 8. Make provisions for expansion in conduit and raceway runs where same cross building expansion joints.
 9. Make connections to motors and controls with an outlet located as close as possible to motor. Make final connections from metal conduit to motors with neat, flexible, liquid-tight conduit in lengths not to exceed eighteen inches.
 10. Conceal conduits and raceways in the structure construction where practicable unless otherwise indicated on the Drawings or required by the Engineer.
 11. Flexible, liquid tight conduit to be used for final motor connections and/or all vibrating equipment.
- B. Concealed Work: Make conduit and raceway runs in concealed work grouped as much as practical to avoid congesting the concealed spaces. The quality of workmanship in electrical work in such spaces shall not be less than that exercised in exposed work.
- C. Exposed Work: Make conduit and raceway runs in exposed work parallel to centerlines and structure surfaces, and perpendicular to centerlines where required, with right angle turns consisting of symmetrical bends or fittings. Maintain at least 6 inches clearance between conduit and raceway runs and mechanical systems pipes, ducts, flues, etc.
- D. Liquid tight flexible metal conduit, as herein specified, shall be used for final connection to rotating and vibrating equipment (transformers, power converters, power conditioners, motors, etc.). A green insulated wire shall be installed in flexible conduits for grounding purposes, and shall be in addition to the neutral wire. Flexible conduit shall not exceed 36-inches (91cm) in length.
1. Flexible conduit shall be installed in a slack condition to minimize the transmission of vibrations from the equipment to the conduit system; use the

maximum allowable length. Flexible conduit shall not be supported from the structure.

E. Wiring: Install wiring in conduit unless indicated otherwise on the Drawings.

3.04 ANCHOR AND FASTENER INSTALLATIONS

A. Auxiliary Support Fabrication: As specified in Section 16070.

B. Threaded Bolts: As specified in Section 16070.

C. Drilled-In Expansion Anchor Installation: As specified in Section 16070.

END OF SECTION

SECTION 16122
LOW VOLTAGE WIRE, CABLE AND ACCESSORIES

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: The work specified in this Section consists of material for furnishing, installing, connecting, energizing, testing, cleaning and protecting low voltage wire and cable, and accessories.
- B. Related Section:
 - 1. Basic Electrical Requirements: Section 16010.
 - 2. Electrical Grounding And Bonding: Section 16060.
 - 3. Electrical Testing: Section 16080.
 - 4. Pull and Junction Boxes: Section 16135.

1.02 REFERENCES

- A. American Society for Testing Materials (ASTM):
 - 1. ASTM B8 Specification for concentric-lay-stranded copper conductors, hard, medium hard, or soft.
- B. Institute of Electrical and Electronic Engineers (IEEE):
 - 1. IEEE 383 Standard for Type Test of Class 1E Electric Cables, Field Splices, and Connections for Nuclear Power Generating Stations.
 - 2. IEEE 1202 IEEE Standard for Flame Testing of Cables for Use in Cable Tray in Industrial and Commercial Occupancies
- C. National Electrical Manufacturer's Association (NEMA):
 - 1. WC-5 Thermoplastic Insulated Wire and Cable.
 - 2. WC-7 Cross Linked Thermosetting Polyethylene Wire and Cable.
 - 3. WC-26 Packaging of Wire and Cable.
- D. National Fire Protection Association (NFPA):
 - 1. NFPA 70 National Electrical Code (NEC).
- E. Underwriter's Laboratories, Inc. (UL):
 - 1. UL 44 Rubber Insulated Wires and Cables.
 - 2. UL 83 Thermoplastic Insulated Wires.
 - 3. UL 1569 Metal-Clad Cables.
 - 4. UL 1581 Electrical Wires, Cables, and Flexible Cords.

1.03 QUALITY ASSURANCE

- A. Unless products meeting the requirements of nationally recognized testing laboratories are not readily available for a category of products, provide products that are listed and labeled by Underwriters Laboratory (UL), approved by Factory Mutual (FM), or certified as meeting the standards of Underwriters Laboratory by the Electrical Testing Laboratory (ETL).
- B. Conform all work to NFPA 70, National Electrical Code.
- C. Install work under supervision of skilled licensed electricians.

PART 2 PRODUCTS

2.01 WIRE AND CABLE

- A. Low Voltage Copper Building Wire:
 - 1. UL listed conductors of 98 percent conductivity copper with type THHN/THWN insulation rated 600 volts.
 - 2. Provide conductors of proper size and ampacity ratings according to NEC Article 310.
 - 3. Minimum Conductor Size:
 - a. No. 12 AWG in power and branch feeder circuits.
 - b. No. 14 AWG in control circuits.
 - c. No. 14 AWG in alarm and status circuits.
 - 4. Except for control wires or where otherwise indicated on the Drawings, do not exceed four conductors (three phase conductors and one neutral) plus ground in raceways or conduits.
 - 5. Conductors for power and branch feeders and control (external of control panels) are solid or stranded copper in sizes up to and including #10 AWG. (No intermixing of conductor types permitted). Provide stranded copper for sizes #8 AWG and larger.
 - 6. ROMEX and BX cable and aluminum conductors are not permitted for use in this Project.
 - 7. Imprint insulated conductors with the date of manufacture, wire type, and manufacturer. Wire and cable manufactured more than 12 months before delivery to the job site shall not be used.
 - 8. Acceptable Manufacturers:
 - a. Cablec Continental Co.
 - b. Rome Cable Corp.
 - c. Okonite Co.
 - d. Or Approved Equal.

B. Metal Clad Cable:

1. Bare soft annealed copper conductors, solid or Class B stranded per ASTM B8. Conductors shall be solid copper in sizes up to and including No. 10 AWG. For sizes No. 8 AWG and larger, conductors to be stranded copper.
2. Type THHN insulation, 600 volts, color coded.
3. Insulated green copper grounding conductor. Meets or exceeds requirements of NEC Table 250-95.
4. Assembled per UL 1569 with non-hygroscopic fillers and binder tape.
5. Close fitting interlocked galvanized steel armor per UL 1569.
6. UL listed as type MC cable.
7. UL listed for cable tray use.
8. Cable shall be suitable for environmental air handling space installation.
9. Imprint insulated conductors with the date of manufacture, wire type, and manufacturer. Wire and cable manufactured more than 12 months before delivery to the job site shall not be used.
10. Acceptable Manufacturers:
 - a. AFC Cable Systems.
 - b. Or Approved Equal.

2.02 WIRE AND CABLE CONNECTIONS

A. Grounding connectors: Conform to Section 16060.

B. Service wires and cables, and wires and cables larger than No. 6: For equipment connection provide connectors approved by the equipment manufacturer and of the types specified below. For all other types of connections provide connectors of one of the types specified below:

1. Split Bolt Connectors: Provide brass or bronze split bolt connectors and provide preformed plastic insulating covers from the same manufacturer.
2. Mechanical compression connectors: Provide compact high copper bronze or brass alloy, two-hole, capable of being installed with one wrench with two clamping bolts, single conductor, or multiple conductor, brass or bronze bolts, plated steel screws are unacceptable. Provide silicon-bronze fasteners for bolting connectors to connections.
3. Crimped compression connectors: Provide two-hole crimped connectors of high conductivity seamless electrolytic wrought copper, electrolytically tin-plated, with two holes, color coded to match dies. Provide adequate area for conduction of the flowing current. Provide tooling to crimp connectors from same manufacturer as connectors.

- C. Control Wiring Connections: Provide crimped nylon-insulated ring terminals for all connections at terminal boards and nylon insulated butt splices with insulation grip. When more than two control wires are to be joined provide junction boxes with terminal boards as specified in Section 16135.

- D. Instrumentation Cable Connector:
 - 1. Provide companion type connectors for instrumentation cable and for the equipment being furnished under this contract.
 - 2. Where providing cable to equipment controllers/enclosures furnished under other sections of this contract, connectors provided with furnished equipment.
 - 3. Terminate wiring as required for proper installation.
 - 4. Acceptable Manufacturers:
 - a. Thomas & Betts Corp.
 - b. AMP Inc.
 - c. Ilsco Corp.
 - d. Buchanan Construction Products.
 - e. Or Approved Equal.

- E. Other Conductors: Provide one of the following type of connectors.
 - 1. Any of the types listed for larger wire.
 - 2. Screw terminals, crimped compression terminals: Provide nylon insulated crimped terminals with copper barrels for making terminal connections of stranded copper wire to screw terminals.
 - 3. Provide pre-insulated, UL Listed, hand or tool installed wire nuts of the spring lock type or compression type for making splices of solid copper wire in dry areas.
 - 4. Screw lock connectors for making terminal connections of solid copper wire.
 - 5. Acceptable Manufacturers:
 - a. Amp.
 - b. Ilsco.
 - c. Brundy.
 - d. Thomas and Betts.
 - e. Or Approved Equal.

2.03 TAPE

- A. Vinyl Insulating Tape: Scotch 33+, black, or approved equal.
- B. Rubber Splicing Tape: Scotch 130C, or approved equal.
- C. Grounding Braid: Scotch 25, or approved equal.
- D. Heat Shrinking: Amp HST1125, or approved equal.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Inspect all conduits, junction boxes, electrical vaults and handholes for cleanliness, lack of burrs, conduits alignment, completeness, and correct deficiencies.
- B. Ensure that two locknuts are installed on all conduits without threaded hubs, that bushings are installed in all conduits with wires larger than No. 10, that grounding bushings and fittings are installed at all places called for in Section 16060.
- C. Check that proper sized boxes are installed. Boxes and conduit fittings must conform to NFPA 70 Article 370 bending requirements.

3.02 PREPARATION

- A. Swab all conduits with a nylon bush and steel mandrel.
- B. Ascertain that pulling calculations have been made and are available for long runs and pulls. Ascertain that a means of controlling pulling tension is installed on mechanical assist devices for pulling cable.
- C. Pre-lubricate all conduits for which the pulling tension calculations are based on a coefficient of friction less than that of a dry conduit.

3.03 INSTALLATION

- A. General:
 - 1. Install all wiring outside of equipment in conduit.
 - 2. Do not perform wiring until work which might cause damage to the wires, cables or conduits has been completed. Take the necessary precautions to prevent the accumulation of water, dirt or other foreign material in the conduits during the execution of the work.
- B. Equipment Ground Conductors: Include a green equipment ground conductor with all runs.
- C. Neutral Conductors:
 - 1. Provide separate neutral conductors for all branch circuits except as follows:
 - a. Three-phase wye-connected panelboards: Common neutrals may be used for circuits from three adjacent single-pole circuit breakers or poles of the same multi-pole circuit breaker.
 - 2. Provide separate neutrals for each single-phase and each multi-phase feeder.
 - a. Size each neutral to the same size as the largest phase conductor.

D. Cable Pulling:

1. Comply with the manufacturer's recommendations for the inspection, handling, storage, temperature conditioning prior to installation, bending and training limits, pulling limits, and calculation parameters for installation of all cable.
2. Lubricate all cables during pulling with lubricants specifically recommended by the cable manufacturer.
3. Limit cable pulling tensions to the maximum pulling tensions recommended by the cable manufacturer. Use dynameter to measure pulling tensions on all runs pulled with mechanical assistance and for all runs where calculations are required to be submitted. If pulling tension is exceeding during pulling, cables shall be removed and marked and not reused.
4. Remove from the job-site and replace all cables that were subjected to excessive bending and tension and all cables that are cracked or have damaged or nicked outer jackets.

3.04 WIRING IDENTIFICATION

- A. Wires shall be color coded to match existing scheme at site.
- B. Identify all control wiring with wire numbers corresponding to record drawings.
- C. Identify all power wiring by circuit and panelboard, switchboard, and motor control center number.

3.05 WIRE AND CABLE SPLICES

- A. Splice cables only in accessible location. Install all service and feeder conductors from end to end without splice. Install all motor conductors from starter to motor without splice.
- B. Protect termination of insulated power and lighting cables from accidental contact, deterioration of coverings and moisture by the use of terminating devices and materials. Terminations shall be made using materials and methods as indicated or specified herein or as designated by the written instruction of the cable manufacturer and termination kit manufacturer.

3.06 TESTING

- A. Electrical Testing: Perform a continuity and insulation test where and as required in Section 16080.

END OF SECTION

SECTION 16135

ELECTRICAL PULL AND JUNCTION BOXES

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: The work specified in this Section consists of material for furnishing, installing, connecting, cleaning and protecting electrical pull and junction boxes.
- B. Related Section:
 - 1. Basic Electrical Requirements: Section 16010
 - 2. Electrical Grounding And Bonding: Section 16060
 - 3. Metallic Raceway Systems: Section 16110
 - 4. Low Voltage Wire, Cable, And Accessories: Section 16122

1.02 REFERENCES

- A. National Electric Manufacturer's Association (NEMA):
 - 1. NEMA 250 Enclosures
 - 2. NEMA OS 2 Sheet Steel Outlet Boxes, Device Boxes Covers and Box Supports.
- B. National Fire Protection Association (NFPA):
 - 1. NFPA 70 National Electrical Code (NEC).

1.03 SUBMITTALS

- A. Testing Agency/Quality Verification: Provide with all product data evidence of testing agency/quality verification, listing, and labeling either by printed mark on the data or by a separate listing card. Provide from product manufacturers a written statement indicating why an item does not have a quality assurance verification. Such statements are subject to the approval of the Engineer.
- B. Product Data:
 - 1. Submit list of materials to be used.
 - 2. Submit catalog cuts of all materials and equipment.
 - 3. Submit manufacturer's comprehensive calculations used to ascertain size requirements.

1.04 QUALITY ASSURANCE

- A. Provide products that are listed and labeled by Underwriters Laboratory, approved by Factory Mutual, or certified as meeting the standards of UL by the Electrical Testing Laboratory unless products meeting the requirements of these testing laboratories are not readily available or unless standards do not exist for the products. Provide products that are listed and labeled or approved as stated above for the location installed in and listed and labeled or approved as indicated and specified for the applications the items are intended for.
- B. Conform all work to NFPA 70, National Electrical Code Articles 250, 300, and 370.
- C. Perform all work under the supervision of a licensed electrician.

PART 2 PRODUCTS

2.01 OUTLET BOXES

- A. Metallic Outlet, Switch, Junction and Fittings: Provide such products meeting requirements of NEC Article 370 for materials and uses in conduit systems, and Fed. Spec W-J-800C. No indented type couplings or connectors permitted on this project.
 - 1. Fittings and boxes stamped steel (concrete tight where required) type construction. Fittings and boxes provided with stamped steel covers and rings for devices and wall finish. Use NEMA Type 4 construction outlet boxes for outdoor and below grade installations.
- B. Acceptable Manufacturers
 - 1. Raco
 - 2. Steel City
 - 3. Appleton
 - 4. Or Approved Equal.

2.02 SMALL SHEET METAL BOXES

- A. Pull and terminal boxes for general purpose dry locations:
 - 1. Provide sheet steel boxes with continuously welded seams, ground smooth, no holes or knockouts.
 - 2. Provide overlapping sheet steel screw cover with captivated screws.
 - 3. Provide oil resistant gasket.
 - 4. Provide ANSI Z55.1 No. 61 gray polyester powder coating over phosphatized surfaces.
 - 5. Conform to NEMA 250 Type 12.
 - 6. Acceptable Manufacturers:
 - a. Hoffman Type SC.
 - b. Or Approved Equal.
- B. Enclosures for equipment and control devices in general purpose dry locations:

1. Provide sheet steel boxes with continuously welded seams, ground smooth, no holes or knockouts.
 2. Provide overlapping sheet steel cover with external screw clamps on one side and continuous hinge on opposite side.
 3. Provide oil resistant gasket.
 4. Provide ANSI Z55.1 No. 61 gray polyester powder coating over phosphatized surfaces.
 5. Conform to NEMA 250 for Type 12 enclosures.
 6. Acceptable Manufacturers:
 - a. Hoffman Type CH.
 - b. Or Approved Equal.
- C. Pull and Junction Boxes for Outdoor Locations:
1. Provide sheet steel boxes with seam-free sides, front and back. No holes or knockouts.
 2. Provide seamless drip-shield on top.
 3. Provide slip-on cover fastened with plated screws along bottom edge.
 4. Provide ANSI Z55.1 No. 61 gray polyester powder coating over phosphatized surfaces.
 5. Conform to NEMA 250 for Type 3R enclosures.
 6. Acceptable Manufacturers:
 - a. Hoffman Screw Cover Type 3R.
 - b. Or Approved Equal.

PART 3 EXECUTION

3.01 INSPECTION

- A. Check conduit stub-ups for correct type, size and location.

3.02 INSTALLATION

- A. Boxes for Outlets and Devices:
 1. Install boxes to be level and plumb. Mount all adjacent boxes in alignment at the same mounting height.
 2. Install device boxes at a uniform height as indicated on the drawings. Mount outlet boxes for equipment within 18-inches (46cm) of equipment power connection.
 3. Do not install flush mounting box back-to-back in walls. Provide minimum 6-inches (150 mm) separation. Provide minimum 24-inches (600 mm) separation in acoustic rated walls.
 4. In interior areas for single devices and two devices and wall outlets, install 4-inch (10cm) square boxes with appropriate plaster ring. Space boxes on opposite sides of the wall 6-inches (15cm) apart. Set plaster ring flush or to protrude less than 1/16-inch (2mm) from wall. Openings for boxes in finished walls must be within 1/16-inch (2mm) of box. Correct all oversize openings in accordance with specifications for wall material.

- B. Other Boxes:
 - 1. Accurately punch all holes with a hydraulic punch and punches sized for the conduit to be installed.
 - 2. Support all boxes by one of the following methods:
 - a. Mount directly to the structure with four (4) or more anchors. Provide 1/4-inch (6mm) spacers behind boxes unless the box has raised pads. Mounting screws must be attached to feet outside the box interior or be sealed to prevent water penetration.
 - b. Two (2) 1-inch (25mm) or larger conduits which exit from a poured concrete floor no further than 18-inches (46cm) from the box.
 - c. Two (2) 1-inch (25mm) or larger conduits which are supported within 12-inches (30cm) from the box.
 - d. Mount on U-channel and structural supports conforming to Section 16070.
 - 3. Provide copper ground lug or 1/4-inch (6mm) X 2-inch (50mm) copper bus bar in all large pulling and junction boxes.
- C. Make up all conduit connections in conformance with Section 16110. Install wiring in conformance with Section 16122 and ground in conformance with Section 16060.
- D. Touch up damaged coatings.

3.03 TESTING

- A. Test all boxes for proper connection to grounding system.
- B. Inspect flush boxes:
 - 1. Opening between box and wall finish is less than 1/16-inch (2mm).
 - 2. Box is flush with wall or protrudes less than 1/16-inch (2mm) and is not set behind wall surface.
- C. Inspect surface mounted boxes for level and plumb within 1/16-inch (2mm).

3.04 PROTECTION

- A. Mask all boxes during painting except surfaces to be painted.
- B. Protect against damage from other work.

END OF SECTION

SECTION 16141
WIRING DEVICES

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: The work of this Section consists of material for furnishing, installing, connecting, energizing, testing, cleaning and protecting wiring devices and cover plates.
- B. Related Sections:
 - 1. Basic Electrical Requirements: Section 16010
 - 2. Electrical Grounding and Bonding: Section 16060
 - 3. Electrical Hangers and Supports: Section 16070
 - 4. Electrical Identification: Section 16075
 - 5. Metallic Raceway Systems: Section 16110
 - 6. Low Voltage Wire, Cable, and Accessories: Section 16122
 - 7. Pull and Junction Boxes: Section 16135

1.02 REFERENCES

- A. National Electric Manufacturer's Association (NEMA):
 - 1. NEMA WD 1 General Requirements for Wiring Devices
 - 2. NEMA WD 6 Dimensional Requirements for Wiring Devices
- B. National Fire Protection Association (NFPA):
 - 1. NFPA 70 National Electrical Code (NEC).
- C. Underwriter's Laboratories, Inc. (UL):
 - 1. UL 20 General Use Snap Switches
 - 2. UL 231 Power Outlets
 - 3. UL 231 Attachment Plugs and Receptacles
 - 4. UL 1681 Wiring Device Configurations

1.03 SUBMITTALS

- A. Testing Agency/Quality Verification: Provide with all product data evidence of testing agency/quality verification, listing, and labeling either by printed mark on the data or by a separate listing card. Provide from product manufacturers a written statement indicating why an item does not have a quality assurance verification. Such statements are subject to the approval of the Engineer.
- B. Product Data:

1. List of all products and accessories.
2. Catalog cuts of all products and accessories to be furnished and installed.

1.04 QUALITY ASSURANCE

- A. Provide products that are listed and labeled by Underwriters Laboratory, approved by factory Mutual, or certified as meeting the standards of UL by the Electrical Testing Laboratory (ETL) unless products meeting the requirements of these testing laboratories are not readily available, or unless standards do not exist for the products. Provide products that are for the location installed and listed and labeled or approved for the voltages and currents applied for the applications the items are intended.
- B. Conform all work to NFPA 70, National Electrical Code.
- C. Perform all electrical work under the supervision of a licensed electrician.

PART 2 PRODUCTS

2.01 SWITCHES AND RECEPTACLES

- A. Provide UL listed specification grade switches meeting Fed. Spec. W-S-896 and NEMA Standard WD 1, and WD 6; and UL listed specification grade receptacles meeting Fed. Spec. W-C-596 and NEMA Standard WD-1 and WD-6 for voltage and current indicated. Provide switches and receptacles with screw terminals. A mixture of manufacturers' products is not permitted.
- B. Toggle Handle Snap Switches: Provide 20 amp, single pole, 3-way or 4-way as indicated, quiet design Hubbell Series 1220 or approved equal.
 1. Control switches, SPDT with center OFF and maintained contacts or SPDT with center OFF and momentary contacts to be of the same basic type, construction and rating as specified above for toggle handle snap switches. See Drawings for additional information.
- C. Standard Face Design Receptacles:
 1. Industrial Specification Grade: Duplex, 125 volts AC, 20 amperes, 2-pole, 3-wire, grounding, Hubbell 5362 series or approved equal.
 2. Commercial Specification Grade: Duplex, 125 volts AC, 20 amperes, 2-pole, 3-wire, grounding, finger groove nylon face, Hubbell CBRF20 series or approved equal.
- D. Ground Fault Circuit Interrupter (GFCI) Receptacles:
 1. Industrial Specification Grade: Duplex, 125 volts AC, 20 amperes, 2-pole, 3-wire, grounding, UL943, solid state circuitry, Hubbell GF5362 series or approved equal.

2. Commercial Specification Grade: Duplex, 125 volts AC, 20 amperes, 2-pole, 3-wire, grounding, UL943, solid state circuitry, Hubbell GF5362A series or approved equal.
- E. Power Outlet Receptacles: Single type rated at voltage and amperage indicated, heavy-duty design, polarized, grounding, Hubbell Twist-Lock and straight blade or approved equal.

2.02 WALL PLATES

- A. Provide a wall plate for each switch, receptacle and special purpose outlet. Do not use sectional gang plates. Use multi-gang outlet plates for multi-gang boxes. Use wall plates of AISI 302 stainless steel (.040 inches thick) (1mm) with satin finish in finished areas.
- B. Provide device plates of heavy cadmium plated steel for use with exposed stamped steel boxes, edges of device plates flush with edges of boxes.
- C. Provide device plates of heavy cadmium plated steel for use with cast FD type boxes, edges of device plates flush with edges of boxes.
- D. Use wall plates for pushbutton and buzzer outlets that have openings to suit the pushbuttons and buzzers. Use plates having the same finish mentioned above.
- E. Provide wet location device covers for use at locations subject to wet or rain conditions. Provide receptacles covers marked "Suitable for Wet Locations While In Use".
- F. Use AISI 316 stainless steel type screws for the installation of wiring devices and wall plates.
- G. Acceptable Manufacturers:
 1. Hubbell.
 2. Pass & Seymour.
 3. Appleton.
 4. Crouse-Hinds.
 5. Or Approved Equal.

PART 3 EXECUTION

3.01 INSPECTION

- A. Check pull and junction box for correct type, size and location.
 1. Flush boxes should be plumb and level to 1/8-inches (3mm) and flush or protrude no more than 1/16-inch (1mm) from the finish surface.
 2. Surface mounted boxes should be plumb and level to 1/16-inch (1mm).
 3. Size of box should conform to NFPA 70 Article 370.
- B. Check wiring pigtails for sufficient length to re-terminate wiring twice and leave 6-inches of slack within the box.
- C. Check ground wires for correct type, size and location.

- D. Correct any and all defects.

3.02 PREPARATION

- A. Remove any oversprayed paint from interior of boxes and from wiring.
- B. Clean interior of box of dirt and debris.

3.03 INSTALLATION

- A. General: Install equipment under supervision of skilled electricians.
- B. Outlet devices on different power systems (house power, laboratory grade power, uninterruptible power supply, emergency generator) shall be clearly identifiable by color coding of receptacle face and labeling.
- C. Adjust final switch and devices to be plumb and level and wall plates of flush boxes to be set flush to wall.
- D. Ground all devices to conform with Section 16060.
- E. Make up all connections to devices to conform with Sections 16122 and 16110.
- F. Provide outlet boxes and supports to conform with Sections 16135 and 16070.
- G. Identify all devices to conform with Section 16075.

3.04 TESTING

- A. Inspect all boxes for proper operation and visual appearance.
- B. Test all receptacles to ensure that ground fault receptacles works, both with the built-in tester and a plug-in tester which simulates a ground fault. Test each receptacle with a plug-in tester that checks for reversed wiring line and neutral wiring, reversed ground and neutral wiring, open, ground wiring, and open neutral wiring.
- C. Test last receptacle in each branch circuit to ensure that the neutral and ground wiring resistance does not exceed 1 ohm between receptacle and panelboard.
- D. Record results and submit report of all testing.
- E. Correct all defects found and retest after correction of defects.

3.05 PROTECTION

- A. Mask all items during painting operation.

B. Protect items against damage during other work.

END OF SECTION

SECTION 16285

TRANSIENT VOLTAGE SURGE SUPPRESSORS (TVSS)

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: The work specified in this Section consists of materials for furnishing, installing, connecting, energizing, testing, cleaning and protecting enclosed transient voltage surge suppressors.
- B. Related Sections:
 - 1. Basic Electrical Requirements: Section 16010
 - 2. Electrical Testing: Section 16080
 - 3. AC Panelboards: Section 16443.

1.02 REFERENCES

- A. National Fire Protection Association (NFPA):
 - 1. NFPA 70 National Electrical Code (NEC).
- B. Institute of Electrical and Electronic Engineers/American National Standards Institute (IEEE/ANSI):
 - 1. ANSI/IEEE C62.41 IEEE Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
 - 2. ANSI/IEEE C62.45 IEEE Guide on Surge Testing Equipment Connected to Low-Voltage AC Power Circuits.
- C. Underwriters Laboratories (UL):
 - 1. UL 1283 Electromagnetic Interference Filters.
 - 2. UL 1449 Second Edition - Transient Voltage Surge Suppressors.
- D. Military Standard (MIL-STD):
 - 1. MIL-STD-220A Method of Insertion-Loss Management

1.03 SUBMITTALS

- A. Testing Agency/Quality Verification: Provide with all product data evidence of testing agency/quality verification, listing, and labeling either by printed mark on the data or by a separate listing card. Provide from product manufacturers a written statement indicating why an item does not have a quality assurance verification. Such statements are subject to the approval of the Engineer.
- B. Product Data and Catalog Cuts: Provide product data for all products provided.

- C. Provide manufacturer's instructions for all Transient Voltage Surge Suppressors.

1.04 QUALITY ASSURANCE

- A. Provide products that are listed and labeled by Underwriters Laboratory, approved by Factory Mutual or certified as meeting the standards of United Laboratories by the Electrical Testing Laboratory for the location installed in and the application intended unless products meeting the requirements of these testing laboratories are not available or unless standards do not exist for the products.
- B. Unless products meeting the requirements of nationally recognized testing laboratories are not readily available for a category of products, provide products that are:
 - 1. Listed and labeled by Underwriters Laboratory.
 - 2. Approved by Factory Mutual.
 - 3. Certified as meeting the standards of Underwriters Laboratory by the Electrical Testing Laboratory.
- C. Conform all work to NFPA 70, National Electrical Code.
- D. Install work by or under supervision of licensed electricians.

1.05 WARRANTY

- A. Transient Voltage Surge Suppressors shall have a warranty for a period of ten years, incorporating unlimited replacement of suppressor parts. Warranty shall be the responsibility of the electrical distribution equipment manufacturer and shall be supported by their respective field service division.

PART 2 PRODUCTS

2.01 TRANSIENT VOLTAGE SURGE SUPPRESSION EQUIPMENT

- A. General Requirements:
 - 1. Provide only products satisfying the applicable requirements for testing and reporting as established herein. Devices proposed for use on this project shall be tested in accordance with UL 1449 Second Edition, as prescribed by ANSI/IEEE C62.45. The residual or "clamping" voltages shall be recorded for all applicable mode of operation and for each of the test standard waveforms referenced. The results of these tests shall be submitted to the Engineer with the product data sheets as outlined under in this Section.
 - 2. Products furnished for use on this project are to incorporate protective elements in all applicable modes, unless specifically indicated otherwise.
 - 3. Install TVSS equipment where so indicated on the Drawings. Voltage class and type of unit to be compatible with distribution voltage being protected.
- B. Integral Transient Voltage Surge Suppressor (Panelboards):

1. TVSS shall be Component Recognized in accordance with UL 1449 Second Edition, Standard for Safety, Transient Voltage Surge Suppressors, and UL 1283, Electromagnetic Interference Filters.
2. TVSS shall be installed by and shipped from the electrical distribution equipment manufacturer's factory.
3. TVSS shall be tested with the Category C3 high exposure waveform (20kV-1.2/50µs, 10kA-8/20µs) per ANSI/IEEE C62.41.
4. TVSS manufacturer must provide verification from an independent test lab confirming TVSS single impulse current rating withstand capabilities.
5. TVSS shall be modular in design. Surge suppression circuits for each separate mode (line-neutral, line-ground and neutral-ground) shall be combined in a single module for each phase. Each MOV shall be thermally protected for low current faults and each mode shall be protected with a surge-rated fuse. Each surge current diversion module shall include solid state status indicator lights.
6. TVSS shall incorporate copper bus bars for the surge current path. Small gauge round wiring or plug-in connections shall not be used in the path for surge current diversion. Surge current diversion modules shall use bolted connections to the bus bars for reliable low impedance connections.
 - a. TVSS shall meet or exceed the following criteria:
 - 1) Maximum single impulse current rating shall be:

L-N	120 kA
L-G	120 kA
N-G	120 kA
L-N + L-G	240 kA
Per phase	240 kA
 - 2) Pulse life test: Capable of protecting against and surviving 5000 ANSI/IEEE C62.41 Category C3 transients without failure or degradation of UL 1449 Second Edition suppression voltage rating by more than 10%.
 - 3) UL 1449 Second Edition component recognized suppression voltage ratings shall not exceed the following:

<u>VOLTAGE</u>	<u>L-N</u>	<u>L-G</u>	<u>N-G</u>	<u>L-L</u>	<u>MCOV</u>
480Y277	600V	600V	600V	1200V	320V
208Y120	330V	330V	330V	700V	150V
7. The ANSI/IEEE C62.41 Category C3 let through voltages shall not exceed the following:

<u>VOLTAGE</u>	<u>L-N</u>	<u>L-G</u>	<u>N-G</u>
480Y277	900V	900V	900V
208Y120	470V	470V	470V
8. TVSS shall be designed to withstand a maximum continuous operating voltage (MCOV) of not less than 115% of nominal RMS voltage.
9. TVSS shall have a minimum EMI/RFI filtering of -50dB at 100kHz with an insertion ratio of 50:1 using MIL-STD-220A methodology.
10. TVSS shall be equipped with onboard visual and audible diagnostic monitoring. Red and green indicator lights shall provide full time visual diagnostic monitoring of the operational status of each phase as well as each surge current diversion module. Audible diagnostic monitoring shall be by way of audible alarm. This

alarm shall activate upon a fault condition. An alarm on/off switch shall be provided to silence the alarm. An alarm push to test switch shall be provided. The TVSS diagnostic monitoring devices shall be mounted on the front of the panelboard enclosure. The diagnostic monitoring circuits shall continually monitor the operational status of the surge current diversion modules. No other test equipment shall be required for TVSS monitoring or testing before or after installation.

11. TVSS shall have a response time no greater than 1 nanosecond for any of the individual Suppression modes.
12. The TVSS devices in lighting and appliance panelboards shall be bus mounted between the main and branch devices. TVSS devices bussed off the end of the panelboard are not allowed. Panelboards with TVSS shall accommodate thru-feed lugs and sub-feed circuit breakers in single section and multi-section panelboards.
13. The TVSS devices in power distribution panelboards shall be cable connected.
14. TVSS shall include Form C dry contacts to monitor the performance of each phase and provide a summary alarm.
15. Acceptable Manufacturers:
 - a. Square D Company/Advanced Protection Technologies, Inc.,
Model XTE/4XGA/240/DC
Model XTE/2XGA/240/DC
 - b. General Electric.
 - c. Cutler-Hammer.
 - d. Or Approved Equal

PART 3 EXECUTION

3.01 INSTALLATION

- A. TVSS installed in panelboards shall conform to Section 16443.
- B. TVSS installed in switchboards shall conform to Section 16442.

3.02 FIELD QUALITY CONTROL

- A. Site Testing: Conform to Section 16080.

END OF SECTION

SECTION 16411

ENCLOSED CIRCUIT BREAKERS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: This Section includes all labor and materials for furnishing, installing connecting, energizing, testing, cleaning and protecting enclosed, low-voltage, individually-mounted molded-case case circuit breakers.
- B. Related Sections:
 - 1. Basic Electrical Requirements: Section 16010.
 - 2. Electrical Hangers And Supports: Section 16070.
 - 3. Electrical Identification: Section 16075.
 - 4. Electrical Testing: Section 16080.
 - 5. Low Voltage Wire, Cable, And Accessories: Section 16122

1.02 REFERENCES

- A. National Electrical Manufacturers Association (NEMA)
 - 1. NEMA 250 Electrical Enclosures.
 - 2. NEMA AB1 Molded Case Circuit Breakers and Molded Case Switches.
- B. National Fire Protection Association (NFPA):
 - 1. NFPA 70 National Electrical Code (NEC).
- C. Underwriters Laboratories (UL):
 - 1. UL 489 Molded-Case Circuit Breakers and Circuit-Breaker Enclosures

1.03 SUBMITTALS

- A. Testing Agency/Quality Verification: Provide with all product data evidence of testing agency/quality verification, listing, and labeling either by printed mark on the data or by a separate listing card. Provide from product manufacturers a written statement indicating why an item does not have a quality assurance verification. Such statements are subject to the approval of the Engineer.
- B. Product Data and Catalog Cuts: Provide product data for all products provided. Indicate clearly the usage of each product.
- C. Shop Drawings: Submit shop drawings for all enclosed circuit-breakers.
- D. Provide manufacturer's instructions for all enclosed circuit-breakers.

1.04 QUALITY ASSURANCE

- A. Provide products that are either listed and labeled by Underwriters Laboratory, approved by factory mutual, or certified as meeting the standards of UL by the Electrical Testing Laboratory (ETL) for the location installed in, and the application intended, unless products meeting the requirements of these testing laboratories are not available or unless standards do not exist for the products.
- B. Conform all work to NFPA 70, National Electrical Code.
- C. Install work under supervision of licensed electricians.

PART 2 PRODUCTS

2.01 ENCLOSED MOLDED-CASE CIRCUIT-BREAKERS

- A. Molded-case circuit breakers, quick make-quick break, unit type with lugs on both ends, having thermal magnetic overload trip, and conforming to NEMA Standard AB-1 and UL-489. Voltage rating, poles, trip setting and UL listed A.I.C. rating as indicated on the Drawings. Equipped with toggle handle mechanically trip-free. Multiple pole breakers shall be equipped with internal common trip. Provide 15 and 20 ampere circuit breakers with lugs for accommodating 1 #14 to 1 #10 AWG wire.
- B. Provide factory installed accessories as indicated and specified.

2.02 ENCLOSURES

- A. Provide enclosures from the same manufacturer as circuit-breaker sized to contain all items required.
- B. Provide enclosures conforming to NEMA 250. Provide enclosures of the type of enclosure as indicated or scheduled on the drawings. Unless otherwise indicated or scheduled, provide surface-mounted NEMA 250, type 1 enclosures.
- C. Provide external operator with positive indication of "ON", "OFF", and "TRIPPED" positions of circuit-breaker. Provide interlock to prevent opening of enclosure-door with Circuit-Breaker in the "ON" position. Provide interlock defeater which requires a common hand-tool to operate. Provide provisions for pad-locking of the circuit-breaker in the "ON" as well as the "OFF" positions by three padlocks.
- D. Provide 100 percent rated copper ground-bus or ground-stud.
- E. Where the circuit-breaker is connected to a system with grounded neutral, provide copper solid-neutral bus or terminal-lug with 100 percent rating, and suitable lugs for all incoming and outgoing cables.

2.03 SOURCE QUALITY CONTROL

- A. Provide standard factory tests of circuit breakers conforming to NEMA AB1 and UL 489.

2.04 ACCEPTABLE MANUFACTURERS

- A. Square D Company.
- B. General Electric.
- C. Cutler-Hammer.
- D. Or Approved Equal.

PART 3 EXECUTION

3.01 PREPARATION

- A. Painted surfaces which will be covered by items of this Section have a prime and finish coat of paint.
- B. Ensure that all indoor areas are enclosed from the weather.

3.02 INSTALLATION

- A. Space enclosures out from surfaces mounted on 1/4-inch (6mm) spacers or U-Channel supports. Provide supports as specified in Section 16070.
- B. Install all circuit-breakers in accordance with the manufacturer's instructions.
- C. Set enclosure top 6-foot 6-inches (198cm) above finished floor or grade unless otherwise indicated or specified.
- D. Punch holes for conduit entries in the enclosures.
- E. In all areas except dry areas install conduit drain-fitting in punched hole in bottom of enclosure, conduit breather fitting in top of enclosure.
- F. Interface with other work:
 - 1. Connect conduits to enclosure with water-tight hubs except in damp locations on the bottom of enclosures. A sealing locknut may be used in place of water-tight hubs and in dry locations two locknuts and bushings may be used.
 - 2. Connect wiring to line and load terminals with lugs provided or approved by manufacturer in conformance with Section 16122. Remove interior or protect interior components during wire-pulling.
 - 3. Identify in accordance with Section 16075.

3.03 FIELD QUALITY CONTROL

- A. Site Testing:
 - 1. Prior to energizing:
 - a. Have insulation testing and setting of overcurrent protective device adjustments made in conformance of Section 16080.

- b. Ensure that all load-side wiring is clear of shorts and has received and passed the insulation tests of Section 16080.
- c. Open all downstream disconnects and open circuit-breaker.
- 2. Final testing after energizing:
 - a. Perform thermographic test and record circuit parameters in conformity with Section 16080.

3.04 PROTECTION

- A. During painting mask all nameplates, all plastic parts, operating shafts and all items not to be painted.
- B. Protect all items during work of other trades including welding and cutting.
- C. Protect circuit-breaker against overloads, short-circuits, and improper operation. Pad-lock off when work is being done on downstream circuits.

END OF SECTION

SECTION 16413

ENCLOSED DISCONNECT SWITCHES

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: The work specified in this Section consists of materials for furnishing, installing, connecting, energizing, testing, cleaning and protecting enclosed disconnect switches and fuses.
- B. Related Work:
 - 1. Basic Electrical Requirements: Section 16010.
 - 2. Electrical Hangers and Supports: Section 16070.
 - 3. Electrical Identification: Section 16075.
 - 4. Electrical Testing: Section 16080.
 - 5. Low Voltage Wire, Cable, and Accessories: Section 16122.

1.02 REFERENCES

- A. National Electrical Manufacturers Association (NEMA)
 - 1. NEMA 250 Electrical Enclosures.
 - 2. NEMA KS1 Enclosed and Miscellaneous Distribution Equipment Switches.
- B. National Fire Protection Association (NFPA):
 - 1. NFPA 70, National Electrical Code (NEC).
- C. Underwriters Laboratory (UL):
 - 1. UL 98 Standard for Safety for Enclosed and Dead-Front Switches.
 - 2. UL 198E Class R Fuses

1.03 SUBMITTALS

- A. Testing Agency/Quality Verification: Provide with all product data evidence of testing agency/quality verification, listing, and labeling either by printed mark on the data or by a separate listing card. Provide from product manufacturers a written statement indicating why an item does not have a quality assurance verification. Such statements are subject to the approval of the Engineer.
- B. Product Data and Catalog Cuts: Provide product data for all products provided. Indicate clearly the usage of each product.
- C. Provide manufacturer's instructions for all enclosed disconnect switches.

1.04 QUALITY ASSURANCE

- A. Provide products that are either listed and labeled by Underwriters Laboratory, approved by factory mutual, or certified as meeting the standards of UL by the Electrical Testing Laboratory (ETL) for the location installed in, and the application intended, unless products meeting the requirements of these testing laboratories are not available, or unless standards do not exist for the products.
- B. Conform all work to NFPA 70, National Electrical Code.
- C. Install work under supervision of licensed electricians.

PART 2 PRODUCTS

2.01 ENCLOSED DISCONNECT SWITCHES

- A. Provide enclosed disconnect switches meeting NEMA Standard KS 1, UL 98 and the following requirements. Horsepower, voltage, amperage, number of poles, and type as indicated on the Drawings.
 - 1. Enclosure: NEMA Standard 250 Type 1, unless indicated otherwise on the Drawings. Construct enclosures of code gauge (UL 98) sheet steel treated with a rust-inhibiting phosphate and finished in gray baked enamel. Enclosure furnished with manufacturer's permanent record of switch type, catalog number, and horsepower rating.
 - 2. Switch Mechanism: Quick-make, quick-break operating handle and mechanism forming an integral part of the box, not the cover, with positive padlocking provisions in the OFF position. Switch current carrying parts electroplated for resistance to corrosion. Switch blades visible in the OFF position when door is open. Switch lugs UL listed for copper cables and front removable.
 - 3. Heavy Duty Type Fusible: Dead front construction with permanent arc suppressors and dual cover interlock (to prevent unauthorized opening of switch in ON position) and positive pressure fuse clips.
 - 4. Heavy Duty Type Non-Fusible: Dead front construction with permanent arc suppressors and dual cover interlock (to prevent unauthorized opening of switch in ON position).
- B. Acceptable Manufacturers:
 - 1. Square D Company.
 - 2. General Electric.
 - 3. Cutler-Hammer.
 - 4. Or Approved Equal.

2.02 FUSES

- A. Current limiting type, of voltage and amperage as indicated on the Drawings. Provide one set of spare fuses for each ampere size indicated and each point of use.

1. Non-Motor Loads: Use Limitron, fast-acting, single element type, UL Class RK1.
2. Motor, Welder and Transformer Loads: Use Fusetron, dual-element, time-delay type, UL Class RK5.

B. Acceptable Manufacturers:

1. Bussman.
2. Gould-Shawmut.
3. Or Approved Equal.

PART 3 EXECUTION

3.01 PREPARATION

- A. Painted surfaces which will be covered by items of this Section have a prime and finish coat of paint.
- B. Ensure that all indoor areas are enclosed from the weather.

3.02 INSTALLATION

- A. Space enclosures out from surfaces mounted on ¼-inch (6mm) spacers or U-Channel supports. Provide supports as specified in Section 16070.
- B. Install all disconnect switches in accordance with the manufacturer's instructions.
- C. Set enclosure top 6-feet 6-inches (198mm) above finished floor or grade unless otherwise indicated or specified.
- D. Punch holes for conduit entries in the enclosures.
- E. In all areas except dry areas, install conduit drain-fitting in punched hole in bottom of enclosure, conduit breather fitting in top of enclosure.
- F. Interface with other work:
 1. Connect conduits to enclosure with water-tight hubs except as follows:
 - a. The bottom of enclosures in damp locations may have a sealing locknut and interior locknut, and grounding bushing in place of a water-tight hub.
 - b. In dry locations, two locknuts and bushings may be used in place of a water-tight hub.
 2. Connect wiring to line and load terminals with lugs provided or approved by manufacturer in conformance with Section 16122. Remove interior or protect interior components during wire-pulling.
 3. Identify in accordance with Section 16075.

3.03 FIELD QUALITY CONTROL

- A. Site Testing:
 - 1. Prior to energizing:
 - a. Ensure that all load-side wiring is clear of shorts and has received and passed the insulation tests of Section 16080.
 - 2. Final testing after energizing:
 - a. Perform thermographic test and record circuit parameters in conformity with Section 16080.

3.04 PROTECTION

- A. During painting, mask all nameplates, all plastic parts, push-buttons, operating shafts and all items not to be painted.
- B. Protect all items during work of other trades including welding and cutting.
- C. Protect disconnect switches against overloads, short-circuits, and improper operation. Pad-lock off when work is being done on downstream circuits.

END OF SECTION

SECTION 16425

AC VARIABLE FREQUENCY DRIVES (VFDs) STAND ALONE TYPE

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: The work specified in this Section consists of requirements for the furnishing and installation of AC Variable Frequency Drives.
- B. Related Sections:
 - 1. Basic Electrical Requirements: Section 16010.
 - 2. Electrical Testing: Section 16080.
 - 3. Power Correction Systems (Active Harmonic Filters): Section 16280.

1.02 REFERENCES

- A. National Fire Protection Association (NFPA):
 - 1. NFPA 70 - National Electrical Code (NEC).
 - 2. NFPA 79 - Electrical Equipment of Industrial Machines/Industrial Machinery.
- B. International Electrotechnical Commission (IEC):
 - 1. IEC 60068 Part 2-3 - Basic Environmental Testing Procedures Part 2: Tests - Test Ca: Damp Heat.
 - 2. IEC 60146.1 - Semiconductor Converters - General Requirements and Line Commutated Converters Part 1-1: Specifications of Basic Requirements.
 - 3. IEC 60664-1 - Insulation Coordination for Equipment within Low-Voltage Systems.
 - 4. IEC 60447 - Man-Machine Interface Actuating Principles.
 - 5. IEC 60439-1 - Low Voltage Switchgear and Control Gear Assemblies.
 - 6. IEC 60947-1 - Low Voltage Switchgear and Control Gear Components.
 - 7. IEC 60364-1 - Electrical Installation of Buildings.
 - 8. IEC 60106 - Guide for Specifying Environmental Conditions for Equipment Performance Rating.
 - 9. IEC 60529 - Degrees of Protection Provided by Enclosure.
 - 10. IEC 61000 - Electromagnetic Compatibility.
 - 11. IEC 60721 - Classification of Environmental Conditions.
 - 12. IEC 60255-8 Overload Relays.
 - 13. IEC 60801-2,-3,-4,-5 - Immunity Tests.
- C. National Electrical Manufacturers Association (NEMA):
 - 1. NEMA ICS 6 - Industrial Control and Systems Enclosures.
 - 2. NEMA ICS, Part 4 - Overload Relays.
 - 3. NEMA Publication 250 - Enclosures for Electrical Equipment.
 - 4. NEMA ICS 2-321 - Electrical Interlocks.
 - 5. NEMA ICS7 - Industrial Control and Systems Adjustable Speed Drives.

6. NEMA ICS 7.1 - Safety Standards for Construction and Guide for Selection Installation and Operation of Adjustable Speed Drives.

D. American National Standards Institute (ANSI):

1. ANSI C84.1 - Voltage Tolerances for North America.

E. Underwriters Laboratories (UL):

1. UL 50 - UL Standard for Safety Enclosures for Electrical Equipment.

2. UL 98 - UL Standard for Disconnect Switches.

3. UL 507 - UL Standard for Safety Electric Fans.

4. UL 508 - UL Standard for Safety Industrial Control Equipment.

5. UL 508C - UL Standard for Safety Power Conversion Equipment.

6. UL 991 - UL Standard for Safety Tests for Safety Related Controls Employing Solid-State Devices.

F. Occupational Safety and Health Administration (OSHA):

1. OSHA[®] 1910.95 - AC Drive Controller Acoustical Noise.

G. Institute of Electrical and Electronic Engineers (IEEE):

1. IEEE 519 - IEEE Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems.

2. IEEE C62.41- IEEE Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.

1.03 SUBMITTALS

A. Furnish copies of approval drawing for Engineer's approval prior to the factory assembly of the AC Drives. Provide drawings consisting of elementary power and control wiring diagrams and enclosure outline drawings. The enclosure drawing shall include front and side view of the enclosure with overall dimensions, required clearances, weight, conduit entrance locations and nameplate legends shown.

B. Standard catalog sheets showing voltage, horsepower, maximum current ratings and recommended replacement parts with part numbers shall be furnished for each different horsepower rated AC drive provided.

C. Submit Operation and Maintenance (O & M) Manuals which shall include detailed parts lists, lists of recommended spare parts, circuit diagrams, maintenance procedures, and operating instructions.

1.04 QUALITY ASSURANCE

A. The manufacturer of the AC Drive shall be a certified ISO 9001 facility.

B. The AC Drive and all associated optional equipment shall be UL listed according to UL 508 C – Power Conversion Equipment. As verification, a UL label shall be attached on the inside of the combination enclosure.

- C. Design, construct and test the AC Drive in accordance with NEMA, NEC, and UL Standards.
- D. Test every AC Drive with an actual AC induction motor at 100% load and temperature cycled within an environment chamber at 104 degrees F. Documentation shall be furnished at the request of the Engineer to verify successful completion of this test.
- E. Test all Drive door mounted pilot devices to verify successful operation. Documentation shall be furnished upon the request of the Engineer.
- F. Perform a Hi-Pot test on the AC Drive with all enclosed devices mounted and wired, prior to shipment.
- G. VFD shall be the standard product of a firm regularly engaged in the manufacture of this product with a record of at least five years successful installations of VFDs similar in size and type to those required for this project.

1.05 SPECIAL REQUIREMENTS

- A. VFD shall be furnished by pump, air handling unit/fan or cooling tower manufacturer who shall assume undivided responsibility for proper matching of the VFD with motor of driven equipment.
- B. VFD manufacturer shall be recommended and approved by pump, air handling unit/fan or cooling tower manufacturer to assure proper matching of VFD with motor of driven equipment.
- C. VFDs and associated filters and power correction systems for all applications shall be of the same manufacturer, see Section 16280.

1.06 FACTORY TESTS

- A. Upon receipt of all approved shop drawings for the AC drives, the manufacturer shall fabricate and factory test the equipment in question.
- B. Upon completion of the factory tests, and prior to shipment, forward the following to the Engineer for review and comments.
 - 1. Certified test report ascertaining that the equipment in question was tested in strict conformance with all applicable Standards, and that the equipment met or exceeded all tests requirements. The test report shall include the manufacturer's factory test plan.
 - 2. A certified quality control report indicating the items checked, the date when checked and initialed by the individual performing the quality control.
 - 3. Provide as part of this submittal the Operational and Maintenance Manuals for the referenced equipment as specified herein in this Section of the Specifications.
- C. Equipment not accepted at the job site without prior receipt of the associated certified test report and the certified quality control report referenced to above.

PART 2 PRODUCTS

2.01 GENERAL DESCRIPTION

- A. The AC Drive shall convert the input AC mains power to an adjustable frequency and voltage as defined in the following sections.
- B. The input power section shall utilize a full wave bridge design incorporating diode rectifiers. Silicon controlled rectifiers (SCR) are not acceptable. The diode rectifiers shall convert fixed voltage and frequency, AC line power to fixed DC voltage. This power section shall be insensitive to phase rotation of the AC line.
- C. The output power section shall change fixed DC voltage to variable frequency, variable voltage AC for application to a squirrel cage induction motor. The inverter shall be switched in a manner to produce a sine coded pulse width modulated (PWM) output waveform. Drive shall be PWM type utilizing insulated gate bipolar transistors (IGBT).
- D. VFD shall start into a rotating load in either direction.
- E. VFD shall adhere to restriction of generated harmonics, as specified in this Section, on the electrical system so that other electrical equipment is not adversely affected.
- F. VFD shall not cause premature motor failure.
- G. VFD shall not cause overheating or excessive vibration or require derating of the driven motor when operating down to 25% of design motor speed.
- H. VFD shall not increase audible noise from the motor by more than 5 dB/A (at a distance of 5 feet from the motor) above the noise level of the motor when operated from a sinusoidal power source.

2.02 CONSTRUCTION

- A. The AC Drive power converter shall be enclosed in a Type 1 enclosure with a circuit breaker disconnect, industrial rated operator controls, user terminal strip connections and bypass controls. Type 1 enclosures shall have top and bottom conduit knockouts.
- B. The enclosure shall provide dedicated user terminals for power and control device connection.
- C. Provisions shall be included for locking the disconnect in the OFF position with a padlock.
- D. All enclosure and heat sink fans shall be accessible from the front and shall not require the removal of the AC drive power converter.

2.03 MOTOR DATA

- A. The AC Drives shall be sized to operate the following AC motors:

1. Motors as furnished by the pump, air handling unit/fan and cooling tower manufacturers.

2.04 APPLICATION DATA

- A. The AC Drive shall be sized to operate a variable torque load.
- B. The speed range shall be from a minimum speed of 1.0 Hz to a maximum speed of 60 Hz.

2.05 ENVIRONMENTAL RATINGS

- A. The AC Drive shall meet IEC 60664-1 Annex A and NEMA ICS 1, UL, and CSA standards.
- B. The AC Drive shall be designed to operate in an ambient temperature from 32 to 104 °F (0 to 40 °C) for Type 1 enclosures.
- C. The storage temperature range shall be -13 to 149 °F (-25 to 65 °C).
- D. The maximum relative humidity shall be 95%, non-condensing.
- E. The AC Drive shall be rated to operate at altitudes less than or equal to 3300 ft (1000 m). For altitudes above 3300 ft (1000 m), de-rate the AC Drive by 1% for every 330 ft (100 m).
- F. The AC Drive shall meet the IEC 60721-3-3-3M3 operational vibration specification.

2.06 RATINGS

- A. The AC Drive shall be designed to operate from an input voltage of 460 VAC (\pm) 10%.
- B. The AC Drive shall operate from an input frequency range of 60 Hz (\pm) 5%.
- C. The displacement power factor shall not be less than 0.95 lagging under any speed or load condition.
- D. The efficiency of the AC Drive, including all internal losses, shall be not less than 96% at any motor speed.
- E. The variable torque rated AC Drive over current capacity shall be not less than 110% for 1 minute.
- F. The output carrier frequency of the AC Drive shall be programmable at 0.5, 1, 2, 4 or 8 kHz. In addition, the output carrier frequency shall be randomly modulated about the selected frequency.

2.07 PROTECTION

- A. Upon power-up, the AC Drive shall automatically test for valid operation of memory, loss of analog reference input, loss of communication, DC-to-DC power supply, control power and pre-charge circuit.
- B. The enclosure shall provide a fully coordinated AIC rating marked on the enclosure nameplate. AIC ratings shall be not less than indicated on the Drawings. Short circuit coordination to UL 508C Power Conversion Equipment and NEMA ICS 7.1.
- C. Subjecting the AC Drive to, at minimum, any of the following conditions shall not result in component failure:
 - 1. Overloads, short circuits (between output phases and to ground), and open circuits at controller output.
 - 2. Input undervoltage and overvoltage.
 - 3. Loss of input phase.
 - 4. Phase reversal.
 - 5. AC line switching transients.
 - 6. Over-temperature.
- D. The AC Drive shall have a minimum AC undervoltage power loss ride-through of 200 milliseconds (12 cycles).
- E. The AC drive shall have a programmable ride-through function, which will allow the logic to maintain control for a minimum of one-second (60 cycles) without faulting.
- F. For a fault condition other than a ground fault, short circuit or internal fault, an auto restart function will provide up to 6 programmable restart attempts. The time delay before restart attempts will be 30 seconds.
- G. Upon loss of the analog process follower reference signal, the AC Drive shall be programmable to display a fault.
- H. The AC Drive shall have a solid-state UL 508 C listed overload protective device and meet IEC 60947.
- I. The output frequency shall be software enabled to fold back when the motor is overloaded.
- J. There shall be three skip frequency ranges that can be programmed to a bandwidth of ± 2.5 Hz.
- K. Provide surge protection per IEEE 62.41 and IEEE 519 to protect the VFD system from damaging transient voltage surges. Fuses shall not be used for surge protection.
- L. Protection of power semiconductor components shall be accomplished without the use of fast acting semiconductor output fuses.

2.08 ADJUSTMENTS & CONFIGURATIONS

- A. The AC Drive will be factory programmed to operate all specified optional devices.
- B. The acceleration and deceleration ramp times shall be adjustable from 0.05 to 999.9 seconds.
- C. The memory shall retain and record run status and fault type of the past 8 faults.
- D. The software shall have an energy economy function that, when selected, will reduce the voltage to the motor when selected for variable torque loads. A constant volts/Hz ratio will be maintained during acceleration. The output voltage will then automatically adjust to meet the torque requirement of the load.

2.09 KEYPAD DISPLAY INTERFACE

- A. The keypad display interface shall offer the modification of AC Drive adjustments via a touch keypad. All electrical values, configuration parameters, I/O assignments, application and activity function access, faults, local control, and adjustment storage, and diagnostics shall be in plain English. There will be a standard selection of 4 additional languages built-in to the operating software as standard.
- B. The display will be a high-resolution, LCD, backlit screen.
- C. The AC Drive model number, torque type, software revision number, horsepower, output current, motor frequency and motor voltage shall be listed on the drive identification portion of the LCD display.
- D. The keypad display shall have a hardware selector switch that allows the keypad to be locked out from unauthorized personnel.

2.10 OPERATOR CONTROLS

- A. The control power for the digital inputs and outputs shall be 24 VDC.
- B. The internal power supply shall incorporate automatic current fold-back that protects the internal power supply if incorrectly connected or shorted. The transistor logic outputs will be current limited and will not be damaged if shorted.
- C. Pull-apart terminal strips shall be used on all logic and analog signal connections in the power converter
- D. Two voltage-free relay output contacts will be provided. One of the contacts will indicate AC Drive fault status. The other contact shall indicate a drive run status.
- E. The combination enclosure shall have the following dedicated operator controls:
 - 1. Start-Stop push button and Hand-off-Auto switch.
 - 2. Manual Speed Potentiometer.
 - 3. AFC-Off-Bypass switch.
 - 4. Test-Normal Selector switch.

5. Power On (red) LED indicator.
6. Drive Run (green) LED indicator.
7. Drive Fault (yellow) LED indicator.
8. Auto Mode (yellow) or Bypass Run (yellow) LED indicator.

F. The combination enclosure shall include terminal point connection for fire /freeze state interlock, to prevent drive and bypass operation.

2.11 DRIVE ISOLATION AND BYPASS CONTACTORS

- A. The AC Drive shall include NEMA rated mechanically and electrically interlocked isolation and bypass contactors complete with Class 20 thermal overload relay, circuit breaker disconnect, control circuit transformer, AFC/OFF/BYPASS switch with transfer delay time capabilities and TEST/NORMAL selector switch.
- B. The operator shall have full control of the bypass starter by operation of the AFC/OFF/BYPASS selector switch.
- C. In the AUTOMATIC mode of operation the bypass contactors shall be sequenced by the 120-volt rated auto start contact provided by the user.
- D. The isolation contactor for the bypass shall be sequenced to provide motor isolation during a drive ready state of operation.
- E. A TEST/NORMAL selector switch shall provide test operation of the power converter while operating the motor in bypass.
- F. Bypass operation shall include protection against undervoltage and phase loss damage, and means to prevent automatic restart damage (e.g., time-adjustable restart).

2.12 HARMONIC MITIGATION

- A. VFDs shall be equipped with input line reactors, percent impedance as indicated on the drawings. These line reactors shall be mounted inside the drive enclosure.

2.13 ELECTROMAGNETIC INTERFERENCE

- A. Per 47 CFR 15, VFD shall be certified to comply with the requirements for class A computing devices and labeled as set forth in part 15.
- B. Electrical and electromechanical components of the VFD shall not cause electromagnetic interference to adjacent electrical or electromagnetic equipment while in operation.

2.14 ACCEPTABLE AC DRIVE (VFD) MANUFACTURERS

- A. Square D Company, Class 8839, Altivar 66.
- B. General Electrical.
- C. Cutler-Hammer.
- D. Or Approved Equal.

PART 3 EXECUTION

3.01 INSPECTION

- A. Verify that the location is ready to receive work and the dimensions are as indicated.
- B. Do not install AC Drive until the building environment can be maintained within the service conditions required by the manufacturer.

3.02 PROTECTION

- A. Before and during installation, the AC Drive equipment shall be protected from site contaminants.

3.03 INSTALLATION

- A. Installation shall be in compliance with manufacturer's instructions, drawings and recommendations.
- B. The AC Drive manufacturer shall provide a factory certified technical representative to supervise the contractor's installation, testing and start-up of the AC drive(s) furnished under this specification.

3.04 TESTING

- A. Test as specified in Section 16080 for functional operation and final system testing.

END OF SECTION

SECTION 16443

AC PANELBOARDS

PART 1 GENERAL

A. SUMMARY

B. Section Includes: The work specified in this Section consists of all materials for furnishing, installing connecting, energizing, testing, cleaning and protecting wall-mounted panelboards.

C. Related Section:

1. Basic Electrical Requirements: Section 16010
2. Electrical Hangers And Supports: Section 16070
3. Electrical Identification: Section 16075
4. Electrical Testing: Section 16080
5. Low Voltage Wire, Cable, And Accessories: Section 16122
6. Transient Voltage Surge Suppressors (TVSS): Section 16285

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM):

1. ASTM B164 Nickel-Copper Alloy, Bar and Wire.
2. ASTM B187 Standard Specifications for Copper Bus, Bus Bar, Rod and Shapes

B. National Electrical Manufacturers Association (NEMA):

1. NEMA 250 Electrical Enclosures.
2. NEMA AB 1 Molded Case Circuit Breakers and Molded Case Switches.
3. NEMA AB 2 Molded Case Circuit Breakers and their Application.
4. NEMA PB 1 Panelboards.
5. NEMA PB 1.1 General Instructions for Proper installation, Operation, and Maintenance of Panelboards.

C. National Fire Protection Association (NFPA):

1. NFPA 70 National Electrical Code (NEC).

D. Underwriters Laboratories (UL):

1. UL 489 Molded Case Circuit Breakers and Circuit Breaker Enclosures
2. UL 50 Cabinets and Boxes
3. UL 67 Panelboards

1.03 SYSTEM DESCRIPTION

- A. Panelboards are connected to system voltages as follows:
 - 1. 480Y/277 Volt, 3-phase, 4-wire.
 - 2. 208Y/120 Volt, 3-phase, 4-wire.
 - 3. 120/240 Volt, 1-phase, 2-wire.

1.04 SUBMITTALS

- A. Testing Agency/Quality Verification: Provide with all product data evidence of testing agency/quality verification, listing, and labeling either by printed mark on the data or by a separate listing card. Provide from product manufacturers a written statement indicating why an item does not have a quality assurance verification. Such statements are subject to the approval of the Engineer.
- B. Product Data and Catalog Cuts: Provide product data for all products provided. Indicate clearly the usage and designation of each product.
- C. Shop Drawings: Submit shop drawings for all panelboards.
- D. Provide manufacturer's instructions for all panelboards.

1.05 QUALITY ASSURANCE

- A. Provide panelboards which have been design tested in accordance with NEMA PB 1.
- B. Provide panelboards which have been production tested in accordance with NEMA PB 1.
- C. Conform all work to NFPA 70, National Electrical Code.
- D. Install work under supervision of licensed electricians

PART 2 PRODUCTS

2.01 MATERIALS AND EQUIPMENT

- A. Basic Electrical Materials: Those products such as conduit, wireways, wire and connectors, cable, support devices, fasteners, and similar devices as required for work of this Section are as specified in other Sections of these Specifications.

2.02 PANELBOARDS

- A. Provide dead-front panelboards as follows:
 - 1. Accommodate bolt-on molded case circuit breakers as specified below.
 - 2. Conform to NEMA PB 1 and NFPA 70, Article 384.

3. Consist of interiors, matching enclosures and covers of a single manufacturer as specified below.
 4. Have circuit breakers of frame sizes, trip ratings, number of poles, and types as scheduled, indicated and noted.
 5. Provide branch circuits phased in sequence vertically and numbered uniformly left to right, top to bottom.
- B. Provide panelboards that are fully rated for a short circuit capacity as scheduled, indicated and noted on the Drawings.
- C. Interiors: Provide interiors, as follows:
1. Provide tin plated main, ground and neutral copper buses conforming to ASTM B187 having not less than 98 percent conductivity.
 2. Mount interiors on galvanized steel backplate.
 3. Make provisions for future breakers and for circuit breakers in all future spaces as indicated, scheduled or noted and so that additional breakers can be mounted without additional connectors or extension of busses.
- D. Provide solderless type main, sub-feed, and through feed lugs rated for copper and aluminum conductors of size, number and type, as indicated, scheduled and noted on the Drawings.
- E. Enclosures:
1. Provide enclosures conforming to NEMA 250 for the types as indicated, scheduled, noted, and specified. Provide NEMA 1 enclosures unless otherwise indicated on the Drawings.
 2. Fabricate from galvanized steel without knockouts.
 3. Provide side, bottom, and top gutters of minimum 4-inch (10cm) width, of minimum 5-1/2 inch (14cm) depth, and sized as indicated, scheduled, and noted and as required by NFPA 70 Article 373 for the actual entry point.
 4. Provide circuit directory of sufficient size to allow 40-characters per circuit; indicate the source of service (ie. upstream panelboard, switchboard, motor control center, etc.) to the panelboard. Mount the directory in a transparent protective covering.
- F. Doors: Provide doors as follows:
1. Provide concealed hinges and trim clamps.
 2. Provide combination catch and master keyed, flat key lock with two keys for each lock and common keying throughout each building of the facility.
- G. Finishes:
1. Factory finish enclosure cover completely using an electro-deposition process that deposits a complete finish coat of paint on all interior and exterior surfaces as well as bolted joints.
 2. Include in the paint process cleaning, rinsing, phosphatizing, prepaint and post paint rinses, bake-cure and cool down steps.

3. Finish switchboards with rust inhibiting primers and electro-disposition acrylic baked enamel top coating of No. 49 medium light grey conforming to ANSI Z55.1.
4. Provide overall finish capable of passing a 300-hour salt spray per ASTM B117 with less than 1/8 loss of paint from a scribed line.

H. Molded case circuit breakers:

1. Provide inverse time and instantaneous tripping characteristics.
2. Provide trip ratings, frame sizes, and number of poles as indicated, scheduled, and noted on the Drawings.
3. Provide full rated circuit breakers with short circuit ratings equal to the panelboard installed as scheduled on the Drawings.
4. Provide molded case circuit breakers conforming to NEMA AB 1, and UL 489.
5. Provide circuit breakers of the same manufacture and type as the panelboard installed.

I. Transient Voltage Surge Suppressor: Provide a transient voltage surge suppressor (TVSS) as specified in Section 16285. Factory install and wire TVSS within the panelboard prior to shipment to the job site. Mount TVSS audible alarm, alarm silence and test switches, and failure indicators (LEDs) on front of panelboard. Provide terminal blocks for external circuit connections.

J. Panelboard Types:

1. Distribution - Square D I-Line.
2. Branch Power and Lighting (208Y/120V) - Square D NQOD.
3. Branch Power and Lighting (480Y/277V) - Square D NF.
4. Branch Power (480Y/277V) - Square D I-Line.

K. Acceptable Manufacturers:

1. Square D.
2. General Electric.
3. Cutler-Hammer.
4. Or Approved Equal.

PART 3 EXECUTION

3.01 PREPARATION

- A. Painted surfaces which will be covered by items of this Section have a prime and finish coat of paint.
- B. Ensure that all indoor areas are enclosed from the weather.

3.02 INSTALLATION

- A. Space enclosures out from surfaces mounted on 1/4-inch (6mm) spacers or U-channel supports. Provide supports as specified in Section 16070.

- B. Install all panelboards and circuit-breakers in accordance with the manufacturer's instructions and NEMA PB 1.1.
- C. Set enclosure top 6-feet 6-inches above finished floor or grade unless otherwise indicated or specified.
- D. Punch holes for conduit entries in the enclosures.
- E. In all areas except dry areas, install conduit drain fitting in punched hole in bottom of enclosure, conduit breather fitting in top of enclosure.
- F. Interface with other work:
 - 1. Connect conduits to enclosure with water tight hubs, except in damp locations on the bottom of enclosures a sealing locknut may be used in place of water tight hubs, and in dry locations two locknuts and bushings may be used.
 - 2. Connect wiring to line and load terminals with lugs provided or approved by manufacturer in conformance with Section 16122. Remove interior or protect interior components during wire pulling.
 - 3. Identify in accordance with Section 16075.
- G. At the end of the project update the circuit directories to reflect as-built conditions. Circuit directions shall be typed.

3.03 CLEANING

- A. After wiring, vacuum out interior and wipe clean of all foreign material.
- B. After painting in areas, remove all over paint, drips and splashes.

3.04 FIELD QUALITY CONTROL

- A. Site Testing:
 - 1. Prior to Energizing:
 - a. Have insulation testing and setting of overcurrent protective device adjustments made in conformance of Section 16080.
 - b. Ensure that all load side wiring is clear of shorts and has received and passed the insulation tests of Section 16080.
 - c. Open all downstream disconnects and open circuit breaker.
 - 2. Final testing after energizing:
 - a. Perform thermographic test and record circuit parameters in conformity with Section 16080.

3.05 PROTECTION

- A. During painting, mask all nameplates, all plastic parts, and all items not to be painted.
- B. Protect all items during work of other trades including welding and cutting.

- C. Protect panelboards against overloads, short circuits, and improper operation, padlock off when work is being done on downstream circuits.

END OF SECTION

SECTION 16462

POWER CONDITIONING UNITS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: The work specified in this Section consists of material for furnishing, installing, connecting, energizing, testing, cleaning and protecting power conditioning units.
- B. Related Section:
 - 1. Basic Electrical Requirements: Section 16010
 - 2. Electrical Grounding And Bonding: Section 16060
 - 3. Electrical Testing: Section 16080
 - 4. Metallic Raceway Systems: Section 16110

1.02 REFERENCES

- A. Underwriter's Laboratory, Inc. (UL):
 - 1. UL 1950 Underwriters Laboratories Inc. Standard for Safety. Electronic Data Processing and Office Equipment Systems.
- B. National Fire Protection Association (NFPA):
 - 1. NFPA 70 National Electrical Code (NEC).

1.03 SUBMITTALS

- A. Testing Agency/Quality Verification: Provide with all product data evidence of testing agency/quality verification, listing, and labeling either by printed mark on the data or by a separate listing card. Provide from product manufacturers a written statement indicating why an item does not have a quality assurance verification. Such statements are subject to the approval of the Engineer.
- B. Product Data:
 - 1. List of power conditioning units and accessories to be furnished and installed.
 - 2. Catalog cuts of all power conditioning units and accessories.
- C. Shop Drawings: Provide shop drawings for the following:
 - 1. Complete outline drawing, showing overall length, width, and height and including ratings of equipment, impedance, and installation restrictions.
- D. Submit Operation and Maintenance (O & M) Manuals which shall include detailed parts lists, lists of recommended spare parts, circuit diagrams, maintenance procedures, and operating instructions.

1.04 QUALITY ASSURANCE

- A. The Power Conditioning Units shall be UL listed according to UL 1950-Electronic Data Processing and Office Equipment Systems. As verification, a UL label shall be attached on the inside of the enclosure.
- B. The Power Conditioning Unit shall be the standard product of a manufacturer who specializes in the manufacturing of Power Distribution Systems with power regulation/conditioning and has been in business for at least 15 documented years, and with a nation wide service organization. The manufacturer shall be an ISO9001 certified company.
- C. Conform all work to NFPA 70, National Electrical Code.
- D. Install work under supervision of skilled licensed electricians.

1.05 FACTORY TESTS

- A. Upon receipt of all approved shop drawings for Power Conditioning Units, the manufacturer shall fabricate and factory test the equipment in question.
- B. Upon completion of the factory tests, and prior to shipment, forward the following to the Engineer for review and comments.
 - 1. Certified test report ascertaining that the equipment in question was tested in strict conformance with all applicable Standards, and that the equipment met or exceeded all tests requirements.
 - 2. A certified quality control report indicating the items checked, the date when checked and initialed by the individual performing the quality control.
 - 3. Provide as part of this submittal the Operational and Maintenance Manuals for the referenced equipment as specified herein in this Section of the Specifications.
- C. Equipment not accepted at the job site without prior receipt of the associated certified test report and the certified quality control report referenced to above.

PART 2 PRODUCTS

2.01 POWER CONDITIONING UNITS

- A. Major Components: The basic components of the Power Conditioning Unit shall consist of base, case isolation transformer, regulating electronics, bypass switch, internal wiring, indicators, single point ground, input and output filters, EMI shielding.
- B. System Package and Construction:
 - 1. Cabinet: The unit shall consist of the following:
 - a. Base: The base shall be of heavy gage sheet metal of a minimum of 10 gauge. Each base shall be painted with baked enamel paint of smooth finish. Four holes of a minimum of 9/16 " (14mm) shall be provided in the base for

- the purpose of securing it to the floor. The case and base shall be designed for Seismic Zone 5 applications.
- b. Internal Sheet Metal: All internal sheet metal, attached to the base shall be plated with gold zinc wash to ensure RFI, EMI susceptibility is reduced to the absolute minimum. Minimum thickness shall be 16 gauge.
 - c. Removable Access Panels: Removable front and rear panels shall be provided.
 - d. Cover: A cover shall be provided with a solid top. The top shall be easily removed to provide access to the transformer taps for field changes.
 - e. Conduit Entry: Input and output conduit entry shall be provided in the right and left lower side panels as well as provision for bottom entry.
 - f. Mounting hardware shall be provided for ceiling mount capability.
2. Isolation Transformer: A multi-shield, convection cooled, 3-phase, isolation transformer shall be provided. The transformer shall be K-13 rated. The windings shall be copper. Construction of the transformer should separate the primary connections and the secondary connections by placing them on opposite sides of the core. In addition, the output terminals of the secondary shall be at opposite ends of the coil for the input terminals of the primary to minimize the possibility of transverse node injection. A copper foil shield shall be provided to allow a large surface area for shunting RFI signals of the core to ground. The isolation transformer shall be mounted on rubber isolation pads to prevent 60 Hz hum of the core from being transmitted to the frame. The transformer core clamp shall be grounded to the frame through a 1" (25mm) copper strap. The transformer insulation system shall be 220° C. Full load taps shall be provided (2) FLAN and (4) FLBN for connection to the tap switching regulator module. Two (2) temperature monitors shall be provided: 140° C (alarm) and 160° C (shut-down).
 3. Regulation Electronics: A solid state, electronic, zero current crossing tap switching regulation system shall be provided. This technology shall use SCR's (Silicon Control Rectifier) technology in its construction and shall be rated at 100% above worst case current ratings (26% below nominal) without any adverse effects. The regulation system shall respond to a change in the input voltage within a minimum of 1 cycle. The electronics shall be separated from the transformer area by a heat shield of sheet metal. This barrier shall be zinc plated for maximum conductivity.
 4. Phase Imbalance: The maximum phase imbalance shall be 2%. The electronics and the transformer characteristics shall be of such construction that will provide for the 2% regulation band under all load and line conditions.
 5. Neutral to Ground Potential: The maximum resistance of the neutral and ground connections shall be less than 0.5 volts maximum potential.
 6. Bypass Switch: A manually operated bypass switch shall be provided, in the event that the regulation circuit malfunctions, it shall select the 100% tap of the isolation transformer and provide unregulated nominal power to the output circuit. Access to the bypass switch shall not require removal of any panels.
 7. Internal Wiring: All internal wiring shall be UL Listed appliance wire or power wiring of multi stranded construction. Secondary and primary power wiring from the transformer shall not be in close proximity of each other.

8. Indicators: The following indicators, supplied in a small enclosure suitable for remote mounting, shall be provided:
 - a. Power On: There shall be one indicator for each phase which has primary power being supplied to it.
 - b. Service Required: Indicators shall be provided to indicate the status of the input transient suppression network fuses. The indicator shall be illuminated any time any of these fuses are open.
9. Single Point Ground (SPG): A single point ground bus shall be provided and shall be of copper construction. Minimum thickness shall be 1/4" (6mm) x 1/4" (6mm) and be silver plated to provide connection of the lowest possible resistance to all ground wires secured to the SPG. The following shall be grounded to the SPG:
 - a. Equipment grounds.
 - b. Neutral of isolation transformer.
 - c. Core of the transformer.
 - d. Primary and secondary shields.
 - e. Base.
 - f. Equipment grounding conductor from the branch circuit.
 - g. Case.
 - h. Regulation electronics.
10. Input Transient Filter: An input transient, electrical noise filter shall be provided with the following characteristics:
 - a. LRC network utilizing the input conductors as part of the filter.
 - b. Line to line filtering.
 - c. Line to neutral filtering.
11. Input Transient Suppression Network: A transient suppression network shall be located on the primary side of the isolation transformer. Each device shall be fused for circuit protection. Visual service indicators (one for each phase) shall be provided to indicate that the transient suppression network is no longer providing protection.

C. Electrical Characteristics:

1. 60 Hz Frequency:
 - a. Rating KVA: 30.
 - b. Input Voltage: 480 VAC.
 - c. Output Voltage: 208Y/120 VAC.
 - d. Input Frequency Tolerance: 60 Hz \pm 3 Hz.
2. Transformer:
 - a. Type: Dry, isolation multi-shield (delta-wye).
 - b. Impedance: 3% to 5% maximum.
 - c. Efficiency: > 96% @ 80% load.
 - d. Load Power Factor: Unity to 0.3 lead or lagging.
 - e. Harmonic Distortion: < 1% maximum added.
 - f. Waveform Distortion at Tap Switching: < 1% added.
 - g. Noise Rejection (typical):

Common mode -	120 dB,
Normal mode -	60 dB/decade.
3. Audible Noise: < 35 dBA.

4. Input Voltage Regulation: + 8% to -10% of nominal.
5. Input Voltage Surges: 20% maximum above nominal line voltage, 50 millisecond maximum duration.
6. Input Voltage Sags: 30% maximum below nominal line voltage, 20 millisecond maximum duration.
7. Line Transients: 20% above nominal voltage for 1/hour maximum.
8. Output Voltage Regulation: $\pm 1\%$ typical, for all load / line conditions.
9. Correction Times: Single tap adjustment: 1 cycle,
Full range adjustment: 2 cycles.
10. Load Rating: Continuous regardless of line / load conditions.
11. Overload Inrush Rating: 200% of full load for 10 seconds,
1000% of full load for 1 cycle.
12. Steady State Voltage Regulation: Shall be $\pm 1.0\%$ for steady state loads varying from none to full.
13. Step Voltage Regulation: Shall be:
 - a. $\pm 5.0\%$ for 25% step load.
 - b. $\pm 8.0\%$ for 50% step load.
 - c. $\pm 10\%$ for 100% step load.
14. Step Load Recovery Time: Shall be $\pm 1.0\%$ voltage within one cycle with up to 100% step.
15. Phase Angle: Shall be $\pm 3.0\%$ with up to 30% unbalance.

D. Operating Environment:

1. Temperature: 32° F to 104° F (0° C to 40° C).
2. Humidity: 10% to 90% relative humidity, non-condensing.
3. Altitude: 0 to 7000 feet (0 to 2133m).

E. Acceptable Manufacturers: Same as existing.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install, connect, and interconnect products where indicated, and in accordance with NEMA Standards, manufacturer's printed installation instructions, and this Section. Make connections in a manner which will insure electrical continuity and operability of the products.
- B. Protect the equipment against foreign matter and moisture during installation.
- C. Install a 3-foot (1m) length of liquid-tight flexible metal conduit between power conditioning unit and fixed conduit system in accordance with Section 16110. Make power conductor connections in accordance with manufacturer's drawings, and as indicated on the Drawings.

- D. Ground in accordance with Section 16060. Provide ground bond for enclosure and neutral, minimum size #6 AWG to nearest structural steel and nearest water pipes to conform with Section 16060 and the NEC.

3.02 FIELD QUALITY CONTROL

- A. Dry out power conditioning units before they are energized.
- B. Check power conditioning unit for tightness of external structural members and mechanical joints in order to minimize audible sound levels. Check the ground connections.
- C. Perform initial start-up in accordance with manufacturer's instructions.
- D. Test as specified in Section 16080.

END OF SECTION

SECTION 16510

INTERIOR BUILDING LIGHTING

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: Requirements for general and emergency egress lighting equipment, components and related installations.
- B. Related Sections:
 - 1. Basic Electrical Requirements: Section 16010
 - 2. Electrical Grounding and Bonding: Section 16060
 - 3. Electrical Hangers and Supports: Section 16070
 - 4. Electrical Testing: Section 16080
 - 5. Low Voltage Wire, Cable, and Accessories: Section 16122

1.02 REFERENCES

- A. The Energy Policy and Conservation Act of 1975 and all amendments thereto, including the National Appliance Energy Conservation Act (NAECA) of 1988 and the Energy Policy Act of 1992.
- B. Federal Communications Commission (FCC) Rules and Regulations, Part 18.
- C. Institute of Electrical and Electronics Engineers (IEEE) Standard C62.41 for transient protection.
- D. American National Standards Institute (ANSI).
- E. Certified Ballast Manufacturers (CBM).
- F. Underwriter's Laboratory (UL)

1.03 QUALITY ASSURANCE

- A. Products to be Underwriters' Laboratories (UL) listed, and each fixture, Emergency Battery Unit, and exit sign bears the UL label. Fixtures to be installed in areas subject to the weather to be UL listed as "Enclosed and gasketed suitable for wet locations". The execution of work of this Section must satisfy the applicable requirements of the latest NEC, regulations of jurisdictional authorities and the National Occupational Safety and Health Act.
- B. Design Criteria:

1. Fixture manufacturers and corresponding model numbers and fixture description as included in the Lighting Fixture Schedule indicated on the Drawings, constitute the Project design. Additional manufacturers with comparable Products that the Contractor proposes to use may be submitted to the Engineer for approval.
2. Lighting fixtures as scheduled are correct for the Project design with respect to visible style, number of lamps and lenses desired but may not cover special required design details. Provide lighting fixtures having such special details as noted in PART 2 - Products. The Engineer assumes no responsibility for clearance, dimensions, tolerances or exact hanging frame dimensions.

1.04 SUBMITTALS

- A. Shop drawings are to show specially-fabricated supporting and fastening devices and details of all assemblies and sub-assemblies.
- B. Bill of material consists of an itemized list of each part identified by a part number and/or manufacturer's numbers (i.e. ballast capacitor ignitor, etc.). This bill of material must be referenced to the shop drawings.
- C. Manufacturers literature to describe lighting fixtures, exit signs, Emergency Battery Units, and indicated appurtenances including all required photometrics.
- D. Substitute Light Fixture Submission: Submit the following data for light fixtures substituted for named manufacturers for the Engineer's approval.
 1. Manufacturer's catalog cuts indicating type, design, dimensions, mounting arrangement and other industry standard lighting fixture information.
 2. Manufacturer's photometric data, distribution curves, isolux charts, glare factor data, and coefficient of utilization.
 3. Calculations showing the substituted fixture is equivalent to the named fixture, including lighting level, Visual Comfort Performance (VCP), glare, Equivalent Sphere Illumination, and energy usage, showing the fixture is suitable for the location installed.

1.05 COORDINATION

- A. Coordinate the installation of lighting fixtures with all building systems and components so as to avoid any conflicts of installation.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Basic Materials: Those products such as conduit, raceway, wire and cable, support devices, fasteners, and control devices, as required for work of this Section are as specified in other Sections of this Specification.

- B. Fixture Supports: In addition to the supporting devices and fasteners as previously specified in Section 16070, provide with the lighting equipment and luminaries specified or indicated suspension accessories, canopies, casing, sockets, holders, reflectors, plaster frames, recessing boxes, etc., as required for support.

2.02 LIGHT FIXTURES AND ACCESSORIES

- A. Fixtures: Those fixtures as indicated on the Lighting Fixture Schedule of the Drawings.
- B. Lamps: Provide proper type lamps for lighting fixtures indicated or scheduled on Drawings and having proper sockets to suit such fixtures.
 - 1. Fluorescent and HID lamps matching voltages to installed fixtures.
 - 2. Fluorescent lamps must be of the energy saving type unless otherwise indicated on the Drawings.
- C. Lighting Fixture Ballasts: Provide UL listed and certified ballasts meeting all requirements of the National Appliance Energy Conservation Act of 1988 and all amendments thereto. Certification by Certified Ballast Manufacturers (CBM) Association in accordance with standard ballast specifications established by ANSI.
 - 1. Fluorescent Fixture Ballasts:
 - a. Provide lighting fixtures equipped with electronic type ballasts.
 - b. Ballasts to be UL listed, Class P, rapid start, input current total harmonic distortion not to exceed 10 percent, be of the low noise level, multi-lamp capacity, to have an average lamp current crest factor of 1.4, a power factor of 90 percent or above, to have a frequency of operation of 20 KHz or greater and be stroboscopic corrected.
 - c. Ballasts are to meet or exceed IEEE C62.41 for transient protection and FCC Rules and Regulations, Part 18.
 - d. Ground ballasts in accordance with NEC and provide in-fixture automatic resetting thermal protection for ballasts and capacitors.
 - e. Acceptable Manufacturers:
 - 1) Advance.
 - 2) Magnetek.
 - 3) Or Approved Equal
- D. Exterior Building Fixtures: Fixtures factory equipped with waterproof gaskets and anodized aluminum frames, unless indicated otherwise on the Drawings, and designed to be completely waterproof.
 - 1. Finish: Free of scratches and other surface blemishes. Final finish to be AA-M12C22A42, Dark Bronze Anodized.
 - 2. Brackets: Of type and style as indicated or scheduled on the Drawings and color matched to the light fixture. Provide outlet boxes, neoprene gaskets and stainless steel hardware to render installation waterproof.

2.03 LIGHTING, AND EMERGENCY BATTERY UNIT SUPPORT DEVICES

- A. Supply pendant stems, special mounting supports and hardware, miscellaneous materials and incidentals required to install the products in place.
- B. Spacers for maintaining clearance between products and concrete, mortar, and other masonry surfaces are to be neoprene.

2.04 GROUNDING

- A. Provide the housing of each fixture with a separate, factory-installed grounding device and ground conductor. The grounding device is to be used for connecting a separate grounding conductor and comply with requirements specified in Section 16060.
 - 1.

2.05 SPARE PARTS

- A. Lamps: Provide a 10 percent extra compliment of each lamp type specified and furnished for the lighting fixtures utilized.
- B. Maintenance Tools: Provide two each of such special maintenance tools as may be necessary for relamping fixtures and for fixture maintenance.
- C. Turn over all spare parts to the ROICC as the project progresses and the particular equipment is substantially completed.

PART 3 EXECUTION

3.01 INSPECTION

- A. Verify that other construction work is complete to the extent that light fixtures may be installed over substrates or incorporated into integrated systems.
- B. Verify locations and clearances of other installed or proposed work and coordinate lighting fixture installations accordingly.
- C. Prior to ordering flush mounted or lay-in installed lighting fixtures, verify their locations and clearances to be coordinated with other construction work.

3.02 INSTALLATION

- A. General: Assemble where required, wire and install lighting fixtures, supports, brackets, and accessories at locations and mounting heights indicated on the Drawings.
 - 1. Methods of Wiring: Perform wiring as specified previously in Section 16122.
 - 2. Ground light fixtures according to requirements of NEC Article 410 and Section 16060.

- B. Recessed Fixtures: Support recessed fixtures on ceiling system structural elements rather than its surface materials such as tiles, plaster, drywall, etc.
 - 1. Use mounting yokes furnished with the fixtures and where required, use supports as previously specified in Section 16070.
 - 2. Locate fixtures in center of panel where installed in modular tile ceilings, unless indicated otherwise. Refer to Architectural Reflected Ceiling Plan included within the Drawing Set.
 - 3. Install suitable sealing gaskets where light leaks occur through gaps between the recessed fixture trim and adjacent surface.

- C. Exposed Fixtures: Install surface mounted and exposed fixtures as indicated on the Drawings.
 - 1. Hang suspended fixtures plumb, with continuous rows of fixtures in alignment.
 - 2. Unless indicated otherwise on the Drawings, mount suspended fixtures in each room or area at the same height regardless of varying clear height conditions.
 - 3. Install surface mounted fixtures drawn up tight against the substrate to eliminate gaps, except where NEC or local code restrictions require a separation between fixtures and substrate.
 - 4. Install Exit fixtures directly over doorways, for those doors as indicated on the Drawings. Center fixtures over doorway and install fixtures to clear door and associated hardware.

3.03 FIXTURE CLEANING

- A. New Fixtures:
 - 1. Follow the cleaning procedures as recommended by the fixture manufacturer with respect to new fixture cleaning for construction work practice.
 - 2. Use only those products for cleaning as outlined in the fixture manufacturer's literature.

3.04 TESTING/CERTIFICATION

- A. Testing/Certification: Consult Section 16080 for requirements for field inspection and testing of the associated electrical distribution system and equipment.

END OF SECTION

SECTION 16711

TELECOMMUNICATIONS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: The work specified in this Section consists of materials for furnishing, installing connecting, energizing, testing, cleaning and protecting a structured wiring system for voice and data.
- B. Related Section:
 - 1. Basic Electrical Requirements: Section 16010
 - 2. Electrical Grounding And Bonding: Section 16060
 - 3. Metallic Raceway Systems: Section 16110

1.02 REFERENCES

- A. American National Standards Institute (ANSI)/Telecommunications Industry Association (TIA)/Electronics Industry Alliance (EIA):
 - 1. EIA-455-21A FOTP-21 Mating Durability of Fiber Optic Interconnecting Devices.
 - 2. ANSI/TIA/EIA-526-7 OFSTP-7 Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant.
 - 3. ANSI/TIA/EIA-526-14A OFSTP-14A Optical Power Loss Measurement of Installed Multimode Fiber Cable Plant.
 - 4. ANSI/TIA/EIA-568-B.1 Commercial Building Telecommunications Cabling Standard – Part 1: General Requirements.
 - 5. ANSI/TIA/EIA-568-B.2 Commercial Building Telecommunications Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components.
 - 6. ANSI/TIA/EIA-568-B.3 Optical Fiber Cabling Components Standard.
 - 7. ANSI/TIA/EIA-569-A Commercial Building Standard for Telecommunications Pathways and Spaces.
 - 8. ANSI/TIA/EIA-606 Administration Standard for the Telecommunications Infrastructure of Commercial Buildings.
 - 9. ANSI/TIA/EIA-607 Commercial Building Grounding and Bonding Requirements for Telecommunications.
- B. Institute of Electrical and Electronic Engineers (IEEE):
 - 1. IEEE 802.3ab Physical Layer Parameters and Specifications for 1000 Mb/s Operation over 4 pair of Category 5 Balanced Copper Cabling, Type 1000BASE-T.

- C. Insulated Cable Engineers Association (ICEA):
 - 1. ANSI/ICEA S-80-576 Communication Wire and Cable for Wiring of Premises.
- D. National Electrical Manufacturers Association (NEMA):
 - 1. NEMA WC 63.1 Telecommunications Cables
- E. Underwriters Laboratories (UL):
 - 1. UL 444 Communications Cables.
 - 2. UL 467 Grounding and Bonding Equipment.
 - 3. UL 1863 UL Standard for Safety for Communications-Circuit Accessories.
- F. National Fire Protection Association (NFPA):
 - 1. NFPA 70 National Electrical Code (NEC).

1.03 GENERAL REQUIREMENTS

- A. Provide a completely cabled and terminated communication system (voice/data/fiber) in a star topology.
- B. Communications system cabling, raceways, pathways, and spaces shall at minimum comply with ANSI/TIA/EIA-568-B.1, -568-B.2, -568-B.3, -569-A and -607.
- C. All multi-mode and single-mode fibers shall be industry rated, best performing design.
- D. Provide grounding and bonding per, at minimum, ANSI/TIA/EIA-607, NFPA 70 and UL 467.

1.04 SUBMITTALS

- A. Testing Agency/Quality Verification: Provide with all product data evidence of testing agency/quality verification, listing, and labeling either by printed mark on the data or by a separate listing card. Provide from product manufacturers a written statement indicating why an item does not have a quality assurance verification. Such statements are subject to the approval of the Engineer.
- B. Third Party Performance Testing: Provide with all product data evidence of third party performance testing by a Nationally Recognized Independent Testing Laboratory.
- C. Product Data and Catalog Cuts: Submit product data for all products provided. Indicate clearly the usage of each product.
- D. Shop Drawings:
 - 1. Telecommunications Drawings: Provide registered communications distribution designer (RCDD) approved drawings complete with wiring diagrams and details required to prove that the distribution system shall properly support connectivity from the telecommunications equipment room to telecommunications work area

- outlets. Show the entrance facility and layout of cabling and pathway runs, cross connect points, MDF, BDF, IDF, grounding system, terminating block arrangements and type. Drawings shall depict final telecommunications cabling configuration, including location, color coding, gauge, pair assignment, polarization, and terminating blocks layout at cross connect points and patch panels after telecommunications cable installation. Provide a plastic laminated schematic of telecommunications cable system showing cabling, BDF's, IDF's, MDF's, and equipment rooms keyed to floor plans by room number.
2. Distribution Frames: Provide shop drawing showing layout of applicable equipment including incoming cable stub or connector blocks, building protector assembly, outgoing cable connector blocks and equipment spaces and racks.
- E. Installer Qualifications: Prior to installation, submit data of installer's experience and qualifications. Installers shall be a Building Industry Consulting Service International (BICSI) Registered Cabling Installation Technician or have experience that shall include 3 years on projects of similar complexity. Include names and locations of two projects successfully completed using optical fiber and copper communications cabling systems. Include written certification from users that systems have performed satisfactorily for not less than 18 months. Include specific experience in installing and testing structured telecommunications distribution systems using optical fiber, Category 3 and Category 6 cabling systems.
- F. Test Plan: Provide a complete and detailed test plan for the telecommunications cabling system including a complete list of test equipment for the UTP and optical fiber components and accessories. Include procedures for certification, validation, and testing.
- G. Submit Operation and Maintenance (O & M) Manuals which shall include detailed parts lists, lists of recommended spare parts, circuit diagrams, maintenance procedures, and operating instructions.. Submittal shall include the requirements of paragraph entitled "Telecommunications Drawings.
- H. Test Reports: Furnish factory reel tests for optical fiber cables.

1.05 QUALITY ASSURANCE

- A. Provide products that are listed and labeled by Underwriters Laboratory, approved by Factory Mutual, or certified as meeting the standards of UL by the Electrical Testing Laboratory unless products meeting the requirements of these testing laboratories are not readily available or unless standards do not exist for the products. Provide products that are listed and labeled or approved as stated above for the location installed in and listed and labeled or approved as indicated and specified for the applications the items are intended for.
- B. Provide products that have been third party performance tested by a Nationally Recognized Independent Testing Laboratory. Test results shall be provided upon request of the Engineer.

- C. Manufacturer Qualifications: Firm specializing in installing work of this Section with minimum five years documented experience in construction of similar equipment.
- D. Conform all work to NFPA 70, National Electrical Code.
- E. Installer Qualifications: Firm specializing in installing work of this Section with minimum three years documented experience.
- F. Install work under supervision of skilled licensed electricians.

PART 2 PRODUCTS

2.01 PUNCH DOWN BLOCKS (VOICE)

- A. Termination Fields:
 - 1. Wall-mount 110 type wiring base with legs, label strip holders, white label strips. Shall conform to Category 6 requirements and be 1000BASE-T compliant.
- B. Connector Blocks:
 - 1. 110 type connector blocks that seat securely on 110 type wiring base providing a gas-tight IDC connection that maintains signal integrity. Four-pair (C-4) or five-pair (C-5) as required by application. Shall conform to Category 6 requirements and be 1000BASE-T compliant.
- C. Acceptable Manufacturers: Same as existing.

2.02 CONNECTORS

- A. UTP Copper Cable (Voice, Data):
 - 1. Connectors shall comply with FCC Part 68.5, and ANSI/EIA/TIA-568-B. UTP outlet/connectors shall be UL 1863 listed, non-keyed, 4-pair, constructed of high impact rated thermoplastic housing and shall comply with Category 6 requirements and be 1000BASE-T compliant. Connectors shall be terminated using a 110-style PC board connector, color-coded for both T568A and T568B wiring. Each jack shall be wired T568B. UTP connectors shall comply with EIA-455-21A for 500 mating cycles.
- B. Fiber Optic:
 - 1. Optical fiber connectors shall be ST, epoxy type UV cure or hot melt, compatible with single mode and 62.5/125 multimode fiber. The connectors shall utilize a zirconia ceramic ferrule. The connectors shall provide a maximum attenuation of 0.3 dB @ 1300 nm with less than a 0.2 dB change after 500 mating cycles. Optical fiber connectors shall comply with EIA-455-21A.
 - 2. Optical fiber adapters shall be suitable for ST style connectors. Adapters shall utilize zirconia ceramic or metallic alignment sleeves. Provide dust cover for all adapters.
- C. Acceptable Manufacturers: Same as existing.

2.03 OUTLETS

- A. Outlets consisting of box, fiber storage/spacer ring, wallplate and connectors.
- B. Outlets shall include provisions for storage and bend radius protection of fiber and copper cabling.
- C. Acceptable Manufacturers: Same as existing.

2.04 PATCH CORDS

- A. UTP Copper Cable (Data):
 - 1. Factory assembled and tested, constructed with stranded wire, equipped with 8-pin modular connectors and strain relief boots, and conforming to Category 5e requirements and be 1000BASE-T compliant. Length as required.
- B. Fiber Optic:
 - 1. Factory assembled and tested, constructed with 62.5/125 um multi-mode or single-mode fiber core as required and equipped with ST connectors. Patch cords shall meet minimum performance requirements specified in ANSI/TIA/EIA-568-B for cables and hardware specified. Length as required.
- C. Acceptable Manufacturers: Same as existing.

2.05 COPPER CABLE

- A. Category 6 Backbone Cable (Voice):
 - 1. Copper backbone cable shall be solid conductor, 24 AWG, 100 ohm, 25-pair UTP (Unshielded twisted pair), NFPA 70 CMR rated, covered with a gray thermoplastic jacket. NFPA 70 type CMP may be substituted for type CMR. Pair twist lengths and frequency per unit length shall be determined by the manufacturer. A minimum of two conductor twists per foot is required. Color coding shall comply with industry standards for 25 pair cables. Jacket sequentially marked at two-foot intervals. Shall conform to Category 5e requirements, ANSI/ICEA S-80-576, ANSI/TIA/EIA-568-B, UL 444 and be 1000BASE-T compliant.
 - 2. Acceptable Manufacturers: Same as existing.
- B. Category 6 Horizontal Cable (Voice, Data):
 - 1. Comply with NFPA 70, NEMA WC 63.1, ANSI/ICEA S-80-576 and performance characteristics in ANSI/TIA/EIA-568-B.
 - 2. UTP (unshielded twisted pair), 100 ohm. Provide four each individually twisted pair, 24 AWG conductors, NFPA 70 CMG rated, with a blue PVC jacket. NFPA 70 type CMP or CMR may be substituted for type CMG. Individual pairs shall be constructed to contain a minimum two twists per foot per each pair. Overall diameter of four pair cable shall not exceed 0.25 inches (6.32 mm). Ultimate breaking strength shall be minimum 90 pounds (40.82 kg). Four pair cable shall withstand a bend radius of one inch (25.4 mm) minimum at a temperature of minus 20 degrees C maximum without jacket or insulation cracking. Conductors shall be color coded and polarized in accordance with ANSI/TIA/EIA-568-B. Jacket

sequentially marked at two-foot intervals. Shall conform to Category 5e requirements and be 1000BASE-T compliant.

3. Acceptable Manufacturers: Same as existing.

C. Category 6 Cross-Connect Wire (Voice):

1. Jacketed or webbed cross-connect wire which binds conductors of a twisted-pair together to maintain consistent conductor spacing and pair twists that will not loosen during cross-connect installation.
2. Solid conductor, 24 AWG UTP(unshielded twisted pair), NFPA 70 CM rated, number of pairs (1, 2, 3 or 4) as required.
3. Shall conform to ANSI/TIA/EIA-568-B Category 5e requirements and shall be 1000BASE-T compliant.
4. Acceptable Manufacturers: Same as existing.

2.06 FIBER OPTIC CABLE

A. Multi-Mode Fiber:

1. Two-fiber (62.5/125 um) cable, 900 um tight-buffered fibers, aramid yarn strength members, orange flexible flame retardant jacket, round duplex configuration, UL type OFNR. The cable shall provide a maximum attenuation of 3.5 dB/km @ 850 nm and 1.0 dB/km @ 1300 nm. The bandwidth of the cable shall be 200 MHz-km @ 850 nm and 500 MHz-km @ 1300 nm.

B. Single-Mode Fiber:

1. Two-fiber (single-mode, 8.3-10/125 um) cable, 900 um tight-buffered fibers, aramid yarn strength members, yellow flexible flame retardant jacket, round duplex configuration, UL type OFNR. The cable shall provide a maximum attenuation of 0.5 dB/km @ 1310 nm and 0.4 dB/km @ 1550 nm.

C. Acceptable Manufacturers: Same as existing.

PART 3 EXECUTION

3.01 PREPARATION

- A. Ensure that painted surfaces that will be covered by items of this Section have a prime and finish coat of paint.
- B. Ensure that all indoor areas are enclosed from the weather.

3.02 INSTALLATION

- A. All voice/data/fiber wires and cables shall be installed in raceways or cable trays as specified in Section 16110.
- B. Conduits shall be restricted to no more than two 90-degree bends or equivalent without a pull box.
- C. Maintain minimum bending radius of changes in direction as follows:

1. 10 times diameter of 4" (100 mm) and larger conduits.
 2. 6 times diameter of smaller conduits.
- D. Avoid bends in conduits from pull boxes.
- E. Except as noted hereinafter for telecommunications cabling and pathways with copper media, keep conduit and cable tray minimum 6 inches (150 mm) away from parallel runs of electrical power equipment, flues, steam, and hot water pipes.
- F. Telecommunications cabling and pathways with copper media shall be installed in accordance with the following criteria to avoid potential electromagnetic interference between power and telecommunications equipment.
1. The interference ceiling shall not exceed 3.0 volts per meter measured over the usable bandwidth of the telecommunications cabling.
 2. Pathways shall be installed in accordance with the following minimum clearance distances of 4 feet (1.2 meters) from motors, generators, frequency converters, transformers, x-ray equipment or uninterruptible power system, 12 inches (300 mm) from power conduits and cable systems, 5 inches (125 mm) from fluorescent or high frequency lighting system fixtures.
- G. Install voice, data and fiber telecommunications cabling and pathway system as detailed in ANSI/TIA/EIA-568-B and -569-A. Screw terminals shall not be used except where specifically indicated on plans. Use an approved insulation displacement connection (IDC) tool kit for copper cable terminations. Do not untwist Category 5e UTP cables more than one half inch (12 mm) from the point of termination to maintain cable geometry. Provide service loop on each end of the cable, 10 ft (3 m) in the telecommunications closet, 3.3 ft (1 m) in the work area outlet for optical fiber and 12 inches (30 cm) for UTP. Do not exceed manufacturers' cable pull tensions for copper and optical fiber cables. Provide a device to monitor cable pull tensions. Do not exceed 25 pounds (110 N) pull tension for four pair copper cables. Do not chafe or damage outer jacket materials. Use only lubricants approved by cable manufacturer. Do not over cinch cables, or crush cables with staples. For UTP cable bend radii shall not be less than four times the cable diameter.
- H. All communications cables for the inside plant shall be terminated. Segregate voice, data and fiber terminations. Provide service loops for all voice (telephone) backbone cables. Provide excess cable at both ends of horizontal cable to facilitate future re-termination. Provide all cross-connecting hardware and jumper cables, including 100% connection capability of all patch cords.
1. All telephone/voice cabling shall be punched down on 110 type punch-down blocks located on telephone backboards. Use C-4 clips for horizontal cable terminations and C-5 clips for riser/backbone cable terminations. All cabling shall be punched down and cross connected. Telephone outlets shall be activated with cross-connect jumper cables between the backbone cable punch-down blocks and the horizontal cable punch-down blocks.
 2. Terminate all copper data cabling on Category 6 type data patch panels with jacks. Terminate all fiber optic cabling using ST connectors on data patch panels. Data

outlets shall be activated with cross-connect jumper cables between the backbone cable patch panels and the horizontal cable patch panels.

- I. Provide outlet box and jack at each voice/data/fiber outlet. Depth of outlet boxes shall be sufficient to allow manufacturer's recommended conductor bend radii.
 - 1. Terminate UTP cable in accordance with ANSI/TIA/EIA-568-B and wiring configuration as specified.
- J. Telecommunications Grounding: Protect all existing grounding and bonding conductors from physical damage.
- K. Provide identification and labeling of communications cables, outlets and equipment per ANSI/TIA/EIA-606.

3.03 CLEANING

- A. After wiring, vacuum out interior and wipe clean of all foreign material.
- B. After painting in areas, remove all over paint, drips and splashes.

3.04 FIELD QUALITY CONTROL

- A. Perform telecommunications cabling inspection, verification, and performance tests in accordance with ANSI/TIA/EIA-568-B.
- B. Inspection: Visually inspect cabling jacket materials for UL or third party certification markings. Visually inspect UTP and optical fiber jacket materials for UL or third party certification markings. Inspect cabling terminations in telecommunications rooms and at workstations to confirm color code for tip and ring pin assignments, and inspect cabling connections to confirm compliance with ANSI/TIA/EIA-568-B. Visually confirm Category 6 marking of outlets, wallplates, connectors, and patch panels.
- C. Verification Tests:
 - 1. UTP backbone copper cabling shall be tested for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors, and between conductors and shield, if cable has overall shield. Test operation of shorting bars in connection blocks. Test cables after terminated but not cross connected. Perform 1MHz to 100MHz scan attenuation test for Category 6.
 - 2. Perform optical fiber end-to-end attenuation tests in both directions using a power meter and light source, testing at both operational windows for both multi-mode and single-mode, and manufacturer's recommended test procedures. Perform tests in accordance with ANSI/TIA/EIA-526-14A, Method B for horizontal, multimode optical fiber and ANSI/TIA/EIA-526-7, Method B for horizontal, single mode optical fiber. Perform verification acceptance tests and factory reel tests.
- D. Performance Tests:
 - 1. Category 6 Links (Voice, Data): Perform UTP permanent link tests in accordance with ANSI/TIA/EIA-568-B. Tests shall include wire map, length, attenuation,

NEXT, Power Sum NEXT, ELFEXT, Power Sum ELFEXT, return loss, propagation delay and delay skew. Each and every link shall be tested and shall pass the requirements of ANSI/TIA/EIA-568-B for Category 6 and IEEE Std. 802.3ab for 1000BASE-T. Any failing link shall be diagnosed and corrected. The corrective action shall be followed by a new test to prove that the corrected link meets the performance requirements. The final and passing result of the tests for all links shall be provided in the test results documentation.

2. Voice Links: In addition to Category 6 tests, test each pair for short circuit, continuity, short to ground, crosses, and reversed polarity. Include operational and ringback, and dial tone tests.
3. Optical Fiber Links: Perform optical fiber end-to-end attenuation tests in both directions and reel tests at jobsite.

3.05 PROTECTION

- A. During painting, mask all nameplates, all plastic parts, and all items not to be painted.
- B. Protect all items during work of other trades including welding and cutting.

END OF SECTION